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IN PREPARATION FOR THE 22ND CONGRESS OF THE SOVIET COMMUNIST PARTY

The 22nd Congress of the Soviet Communist Party will sum up the great progress made by our country in industrial, agricultural and cultural development and will adopt the Party's new program for the construction of a communist society. In company with the whole Soviet people, the many thousands of workers in all branches of Soviet science await this outstanding occasion.

An All-Union Conference of Scientific Workers held in the Kremlin between 12 and 14 June 1961 discussed the main problems associated with scientific development in our country and the strengthening of the relations between science and production. The conference criticized shortcomings in scientific work, particularly in relation to planning and coordination, where there was unnecessary duplication in the development of some scientific trends, while other trends were underestimated and insufficiently developed.

Academician M. V. Keldish, the President of the USSR Academy of Sciences, laid particular stress in his paper on the role of the scientific community, and especially learned societies, conferences and congresses, in the development and coordination of work on important scientific problems.

Soviet entomologists are involved in the solution of many scientific problems and practical tasks of a general biological nature, and especially of problems and tasks related to agriculture, forestry, medicine and veterinary practice. They have to solve a wide variety of theoretical and practical problems, that are often of economic importance, in their daily work.

Soviet entomologists have made some important progress in agricultural and medical entomology, in studying the rich insect fauna of the Soviet Union and in such theoretical fields as insect phylogeny and embryology and some branches of ecology, to mention a few. Nevertheless, life continually confronts us with new tasks which can only be solved by further raising the level of entomological research and, especially, by developing a number of branches of entomology which have not yet received sufficient attention in establishments devoted to research and to the applications of research.

Firstly, we are noticeably backward in developing various aspects of experimental ecology and the ecological physiology of insects, although such research is of the greatest importance in forecasting the population dynamics of insect pests, in establishing when control measures should be undertaken and what methods should be employed, in toxicology and in developing effective methods for the use of insects as entomophages and pollinators. A sound knowledge of insect ecology and physiology also makes insects very suitable experimental subjects for the solution of many problems in general biology, including problems relating to comparative physiology, biochemistry, endocrinology, genetics, population dynamics and the problems associated with the conquest of space that are of such importance at the present time.

Entomologists are also faced with major tasks in the study of the insect fauna and its biology, especially in relation to the agricultural and industrial utilization of more and more territories, many of which are in the arid districts of Kazakhstan and Central Asia, and the Far East. Although several generations of entomologists have studied the insect of Central Asia, for example, or the Far East, its great wealth and variety constantly raise new problems. In addition to the many species previously unknown to science discovered in these districts every year, there are also many new and previously unknown pests and useful forms. Nor should it be forgotten that a great deal of work remains to be done on many insect groups and on the insect fauna of European Russia. In addition, Soviet entomologists are becoming increasingly concerned with the faunas of the previously poorly developed countries of Asia and Africa and are advising specialists in countries recently freed from colonial oppression. This has led to a very considerable expansion in faunal studies and we need a knowledge of the world insect fauna in addition to that of the Soviet Union. Much work needs to be done in the preparation of keys for identification, handbooks and other publications on which entomologists can base their work.

The problems facing entomologists in agricultural entomology are particularly extensive. Many dangerous insect pests continue to do great damage to agriculture in all regions of the country, where they reduce the yield of grain and industrial crops and of vegetables and fruit. Particular attention must be paid to toxicological questions in relation to the testing and use of the many new chemical poisons, especially in relation to the capacity of pests to acquire tolerance to certain poisons. The judicious combination of chemical, agricultural and biological control methods to create conditions in which the possibility of large scale breeding of pests is reduced remains of overwhelming significance. Research on the ecomomic efficiency of control measures against insect pests must be greatly intensified.

There are equally extensive and important problems in forest entomology. We are still not in a position to predict mass outbreaks of forest pests with sufficient rapidity and to prevent the formation of new foci. Now that reforestation and correct management are coming to be of particular importance, the protection of the forests from leaf, needle and trunk pests and diseases should be accorded its rightful place in plans for the national economy. Control of the Siberian pine-tree moth continues to be of overriding importance in the forests of Siberia.

Progress in medical and veterinary entomology has not yet led to final solution of a number of problems that require the undivided attention of large groups. In particular, the control of thick-borne diseases of man and domestic animals continues to be of the first importance in many districts, and in the Central Asian republics mosquito-borne infections are also still of great significance. Nor must we weaken in our attention to the vector of a number of other transmissible diseases, for which the danger of primary infection has been largely eliminated in our country. Control of blood-sucking Diptera is of great economic importance, especially in districts of Siberia and the Far East; successful solution of this problem awaits the combined work of entomologists and specialists in other fields.

Various species of warable flies continue to cause great losses in animal husbandry, since the control measures developed by entomologists are still insufficiently applied in agricultural practice. All these and many other problems not here mentioned depend for their solution on a marked improvement in the organization of entomological research. Although some measure of coordination is provided in agricultural entomology by the annual conferences organized by the plant protection section of VASHKNILL and the All-Union Institute of Plant Protection, the only coordination of work in medical and veterinary entomology and on theoretical problems is confined to individual questions and is quite inadequate. Such coordination is quite essential even for the planning of entomological work designed to reveal features that will open up new paths for progress,

since lack of coordination may lead to important links in the chain being overlooked and to deficiencies which can subsequently only be rectified with very great difficulty.

In view of the new organizational arrangements now being adopted in plant protection, particular attention should be paid to the correct use of the services of local entomological specialists, who should mainly be concerned with their direct work, which is the study of agricultural and forest pests and control measures. At the same time, even more attention should be paid to the training of entomologists with various types of qualification in institutes of higher education, including high schools of agriculture and forestry and universities, and to increasing the number of post-graduate students in the Academies of Sciences and in institutes of higher education. We should not forget that, in view of the great problems now facing entomologists, there is still a great need for trained workers in many branches of the science.

The Presidium of the All-Union Entomological Society calls on all members of the Society and all Soviet entomologists to mark the 22nd Congress of the Soviet Communist Party by a further improvement in their work, by being more active in the solution of the scientific and practical problems facing Soviet entomologists and by intensifying their popularization of entomological knowledge.

ASTRONOMICAL ORIENTATION OF ARTHROPODS

G. A. MAZOKHIN-PORSHNYAKOV

Introduction. All animals are restricted, for obvious reasons, to a given part of space. This fact in itself presupposes the ability of creatures that can move to orient themselves, i. e. to maintain some course and not to move chaotically and blindly.

The simplest form of visual orientation consists of maintaining a steady angle in relation to a given point of orientation, thus enabling the animal to maintain its initial course without deviating. The point of orientation may be an object or a light source, such as a lamp (in experiments), and in nature the sun or, as has recently been revealed, the polarized light of the skiy. In the latter two cases one must speak of astronomical orientation, the initial form of which can easily be seen in the larvae of sawflies or the caterpillars of butterflies and moths. Thus, the larva of the sawfly Neodiprion crawls in a straight line when a polarizing film is fixed above it, but turns in the same direction when the polarizer is rotated (Wellington, et al., 1951). The constant direction of the oscillations of plane polarized light enables the larva to maintain a straight course in the absence of other reference points.

Animals whose mode of life compels them to cover relatively long distances and to return on each occasion, to the nest for example, are faced with more intricate problems. Bees, for example, gather nectar and pollen within a radius of 5 km from the hive, flying back and forth all day. Ants travel for hundreds of meters from their nest.

How do they find their way when there are no suitable reference points on the ground? By the sun? But the sun does not remain in the same place. If the sun is to be used continually as a compass, allowance must be made for its diurnal motion (rotation of the earth), i. e. the animal must have a clock. It must also remember the azimuths of its path or it will not reach the required point and return.

How do animals, and especially arthropods, orient themselves? The efforts of several scholars, especially Frisch and his pupils, have recently revealed that insects and other arthropods have "clocks" and can use a celestial compass — the sun, and that crustaceans also use the moon. They can also establish the position of the sun from the direction of the polarization plane of light in a cloudless portion of the sky, and bees can locate the sun in the sky even in overcast weather when man cannot see the sun. Arthropods have a memory and can make "mental" corrections to the azimuth in relation to the sun to compensate for the axial rotation of the earth and to calculate their own return path. This navigation by arthropods is at least as involved as the "navigational calculations" of migratory birds that take their direction from the sun (Kramer, 1953) or from the stars at night (Sauer, 1957).

"The clock" of bees and other arthropods. It was already known that bees could be taught to fly to food at a given time (Beling, 1929). This experiment succeeded even when the hives and food were kept day and night in a closed space continually lit by artificial light. The fact that the bees visited the feeding troughs at a given time in both variants of the experiment apparently indicated that they had their own "clocks". Is it not possible, however, that bees can tell the time by the sun, even when isolated from daylight, by some sense unknown to man?

To solve this problem Frisch and his colleague Renner (1955, 1957) carried out the following experiment in 1955.

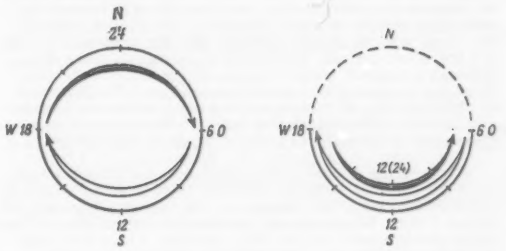

Fig. 1. - Diagram of the "clock" of bees (left) and of arachnids and crustaceans, synchronized with the passage of the sun. The diagram shows equal length day and night, with the sun rising at 0600 and setting 1800 (local solar time). Light arrow - movement of the "clock hand" of the animal during the day, black arrow - at night.

In Paris, in an isolated chamber with artificial lighting, bees were taught to fly to food at given times. The bees were then flown to New York by plane and placed in a similar isolated chamber. The next day the bees assembled at the feeding trough at the same time by Paris time and not by local New York time (5 hours later) when the sun was at the same altitude as in Paris on the day before. It therefore follows that bees actually recognize the time by their internal "clock" and not by the sun.

An apian "clock" can be retarded or advanced but, probably, not stopped. When, for example, bees have been kept at a temperature of below zero in a refrigerator they come late to the feeding trough. If, on the other hand, they are kept for a while at an unusually high temperature they appear earlier at the trough. Nevertheless, the "clock" runs quite steadily in the wide temperature range encountered in their normal life. When bees are kept for several days in darkness or in unvarying light conditions the "clock" does not stop. It also continues to function in narcotized insects. We shall see later that, under natural conditions, the "clocks" of arthropods are synchronized with the motion of the sun, i. e. they are set by local solar time. If, however, an artificial (phase displaced) rhythm for the alternation of day and night is established, the internal "clock" may be synchronized with the different rhythm of solar motion. Several types of "clock" have been discovered in animals.

Bees have the most highly perfected "clock". It runs perpetually, is endogenously regulated by the internal physiological rhythm and the "hand" completes a full revolution in 24 hours (see the diagram). In order to use the sun as a compass, a "clock" of this type should sometimes be set by local solar time. If then the "hand" of the "clock" is axially perpendicular to the plane of the solar orbit it will always point in the direction of the sun (at any hour and at any time of year).

The second type of "clock", which is known in crustaceans, spiders and certain insects, is regulated both by the internal physiological rhythm and exogenously by the external rhythm of day and night. The "hand" of this "clock"

fluctuates like a pendulum, but also has a 24 hour period: during the day it follows the direction of the sun but at night the "hand" moves backwards. Such "clocks" are apparently regulated once and for all. They run repeatedly both in darkness and in extended hours of illumination, but the amplitude of the fluctuation of the "hand" is dependent on the duration of the day, i. e. it changes with the season. It is also clear that the "hand" moves faster at night to the extent that the day is longer than the night. Such "clocks" should be synchronized both to the diurnal and to the seasonal motion of the sun simultaneously by the effect of the length of day.

"Clocks" of the third type, which are so far only known in water-skaters, are entirely regulated by exogenous rhythm and therefore stop quickly in darkness or in continual illumination. They follow the pattern of the pendulum "clocks" of crustaceans and spiders, but the movement, period and amplitude of the "hand-pendulum" are entirely dependent on the external rhythm of the alternation of light and darkness. Under normal conditions the swing takes 24 hr, but it can be adapted to a different day, such as 16 or 10 hr periods with night and day of equal duration. The "winding up of the clock" and its synchronization with the motion of the sun are therefore entirely effected by the duration of the day, although a stopped "clock" always starts again in the same direction -- counter to the earth's rotation. The direction in which the "hand" moves is associated with some internal mechanism. The factors that indicate the existence of a given type of "clock" will become apparent subsequently.

Orientation of bees under clear and clouded skies and their navigational system. Santschi's experiments with ants (1911) established that insects use the sun as a celestial reference point. When ants are crossing an unfamiliar and uniform area in search of food they maintain a constant angle to the sun. If the sun is shielded but shown to the ant reflected in a mirror from the opposite side, it turns round and begins to move in the opposite direction. Wolf (1927) later found that in areas such as large level meadows without ground reference points bees also find their way to a source of nectar by the sun. Nevertheless, it is only very recently that Frisch and his pupils have shown that bees take constant note of the orbital movement of the sun. They have revealed the amazing mastery shown by the bees in using the celestial compass.

The following experiment was carried out in 1949. A hive was first placed near the bank of a mountain lake but separated from the water by a small settlement. A group of marked bees fed for several days 200 m to the west of the hive on the opposite bank of the lake. One morning the hive was moved to a new position several kilometers away that was unknown to the bees. Observers stationed themselves by small stands with bait placed on all sides of the hive at a distance of 200 m. The tagged bees were only found at the stand to the west. They flew to the west in search of food, although at that time in the morning the sun was in the south east and not in the west, as had been the case when they fed on the bank of the lake. The unfamiliar landscape did not confuse them (Frisch 1950).

Lindauer (1957) made an even more effective experiment. When at Peradeniya (Ceylon) in the tropics, he taught bees to seek out food to the north of the hive at midday. On the night of 23-24 April he flew with the hive to the north, to Poona (India). On 24 April the sun passes through the zenith at mid-day at a latitude between the two points. But whereas the sun makes an angle of 5° 35' to the north at Peradeniya at 12 o'clock on this day it makes the same angle to the south at Poona. How did this affect the orientation of the bees, that had become accustomed in Ceylon to fly to the north for food at mid-day, i. e. directly towards the sun? In India they flew to the north, i. e. in Poona they also sought food in the direction of the sun although there it was not in the north at midday, as in Ceylon, but in the south. These experiments proved conclusively that bees actually orient themselves by the sun despite its movement through the heavens.

On returning home from Ceylon Lindauer took some bees with him. This introduced an unexpected shift of longitude of 69° to the west, and the internal "clock" of the bees should have been 4-1/2 hr ahead of the local Munich time. This would indicate that the apian "clock" was out of synchronization with the position of the sun in the heaveans for the longitude of Munich. Subsequent experiments in fact revealed that at first the bees orientated themselves solely from ground reference points and not by the sun. The possibility is not, of course, excluded that these were actually young bees that had emerged after the return from Ceylon. At the same time, other experiments have shown that if young bees are ecloded in an artificially lit container, they are not immediately able to use the sun as a compass under natural conditions. They cannot do so until they have observed the diurnal path of the sun for a number of days. In other words, they need some time to synchronize the running of the "clock" which the position of the sun in the heavens (Lindauer, 1957).

It is not surprising that bees from the northern hemisphere transported to Brazil more than 425 years ago originated local races which became accustomed to compensating for the counterclockwise movement of the sun (Kalmus, 1956). The bees were therefore able to adapt themselves to the fact that the sun moves from right to left in the southern hemisphere and is in the north during the day. Moreover, families of bees that live at any point in the tropics (between the Tropic of Cancer and Capricorn) must adjust in this respect twice a year, since the sun twice crosses the equator (celestial) during the year.

Unlike other insects, bees do not only make individual use of the celestial compass for their own orientation. They can use it to determine the coordinates of a nectar supply and can pass on this information to other members of the community. This real navigational service can be seen in action by watching the behavior of bees in the hive.

Frisch (1946) showed that a bee acting as a scout informed the inhabitants of the hive of the discovery of a nectar supply by what have been called "dances". If the supply is within 50-100 m of the hive the scout performs a "circular" dance. More distant supplies and the distance to them are indicated by a "meandering dance". When the "meandering dance" is executed on a horizontal surface from which the sun is directly visible, such as the area in front of the opening to the hive, the straight course of the dancing bee points in the direction of the nectar. The other bees present repeat the "meandering dance" after the scout, memorize the angle between the direction to the sun and the direction of the straight course of the "dance" and fly off to forage at the same angle to the sun. The distance to the food supply is indicated by the tempo of the scout's dance.

The position is more complicated when the "meandering dance" is executed on the vertical honeycombs within the hive, not directly accessible to the sun's rays. In this case the bees transpose the angle relative to the sun to an angle relative to the direction of the force of gravity; the direction counter to the force of gravity is taken by the bees as the direction to the sun. Thus, if the straight course of the "meandering dance" runs vertically upwards, this indicates that the required direction of flight is towards the sun. If the course runs at an angle to 30° to the left of the direction of the force of gravity this indicates that the nectar supply is at an angle of 30° to the left of the direction to the sun, and so on (Frisch, 1956/57). [1]

A "dance" on a horizontal surface in the open is the simplest initial method of indicating direction. The dwarf bees (Apis florea) found in India "dance" only on the horizontal surface provided by the consolidated roof of their single honeycomb, suspended beneath a branch. Dwarf bees are less expert navigators: they cannot convert an angle relative to the sun to an angle relative to the direction of the force of gravity (Lindauer, 1956).

In temperate latitudes the sun is never at the zenith, and can therefore serve as a reference point for bees at any time of day. The situation is different in the tropics, where the sun is very high above the horizon during the day and is zenithal at midday on some days. Lindauer (1957) made the following experiment in the tropics. On a day when the sun was due to pass through the zenith he so arranged his experiment that a scout bee found food

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[1] Mel'nichenko and Selezneva (1959) have expressed a particular view on the achievement of Frisch and his pupils in deciphering this "language" and on the astronomical orientation of bees in general. From some experiments with bees they completely reject the signalling (orienting) significance of the "meandering dance" and orientation of bees by a celestial compass.

at midday. On returning to the hive the bee started to "dance", but its "dance" was without pattern, i. e. the bee was disorientated at midday when the sun was immediately overhead. As soon as the sun had shifted from the zenith by 2-3° the bee was able to give a correct indication of the direction. This means that the "meandering dance" of bees is, in fact, orientated relative to the sun.

The following experiments (Lindauer, 1957) show how completely the apian "clock" is synchronized with the passage of the sun. Young bees ecloded in a container isolated from natural light were let out only after midday for 35 days. They flew around from 12:30 until evening and were kept in a darkened room during the night and morning. At another site these bees were once again taught to find food in a given direction from the hive, but still in the afternoon. On the morning of the next day the hive was once again shifted to a locality unknown to the bees and the entrance uncovered. The morning flight of bees went in the same direction in search of the food as on the previous day. It therefore follows that bees whose experience is only of the waning part of the solar orbit can orientate themselves correctly by the morning sun. An acquaintance with a quarter of the daily path of the sun was sufficient to give an idea of the whole diurnal path.

During "dances" in the hive bees make allowance for the passage of the sun and even for its nocturnal path. Thus, during the swarming period, the quartermaster bees have the task of finding a suitable site for the new queen and family leaving the hive. When it has found a suitable site for the nearest, the quartermaster bee also indicates its direction by a "meandering dance." It remains in the hive and "dances" for hours on end continually altering the direction of the straight course. This indicates that the bee is continually making corrections corresponding to the passage of the sun in the angle between the direction to the sun and the site of the future nest. The same thing happens when the bees are kept isolated from natural light. Its own "clock" and previous acquaintance with the diurnal passage of the sun is all that the bee needs to indicate the required direction (Lindauer, 1954). Bees do not fly from the hive at night, but if it is lit the quartermaster bee can sometimes be prompted to "dance" at night. It correctly indicates the direction to the nesting site that it has found during the day. It therefore follows that bees can "imagine" the passage of the sun at night, when it is beneath the horizon (Lindauer, 1957). The "clock" is a 24 hour one and the "hand" continually follows the passage of the sun.

It was hitherto thought that bees could see the sun at any time of day. After all, they still fly when the sun is concealed behind a cloud and even in completely overcast weather. How do they orientate themselves when the sun cannot be seen directly? Frisch (1949) and his pupils established that even under such conditions bees orientate themselves by the sun and determine its position visually.[2] It has been established that the faceted eyes of bees and other arthropods are responsive to the polarization of light. The light of the blue sky is more or less polarized and the polarization plane and intensity in different areas of the sky are strictly related to the position of the sun in the heavens. The polarization picture alters as the sun moves. It is, therefore, theoretically possible to determine the position of the sun from any patch of blue sky at any time during the day. This is in fact done by bees, which can determine the position of the sun from any break in the clouds. Therefore both the sun and the polarization picture to which it gives rise in the blue sky can serve as a compass for bees (Mazokhin-Porshnyakov, 1959). At the end of this paper I shall deal with the mechanisms involved.

Frisch (1948) noted that bees "dance" and correctly indicate the direction to nectar even in absolutely overcast weather, when man cannot see the sun. If "dancing" bees are shielded from the sky by various light filters they still continue to give a correct indication of direction if the filter passes ultra-violet rays. The "dance" is not disoriented by glass that is black to man and only passes ultraviolet rays (λ300-400 mμ). If one knows the position of the sun in the sky and places a completely non-transparent screen between it and the head of the bee, the "dance" becomes chaotic. The fact is quite plain: bees, whose eyes are extremely sensitive to ultraviolet light, can see the sun through a film of clouds, apparently by direct reception of ultraviolet solar radiation.

Frisch later made the following experiments with the astronomer Professor Schmeidler (Frisch, Lindauer, Schmeidler, 1960). On overcast days they made parallel recordings of the direction of the "meandering dance" for different cloud densities and took photographs of the sky on contrast film through a UG-2 light filter.[3] They found that the "dances" of the bees were only disoriented when, on the basis of the negative image density of the solar disc and background (clouds), the brightness of the sky in the immediate vicinity of the sun was no more than 5% brighter than that of the surrounding clouds. In other words bees can see the sun through clouds when there is a difference of as little as 5% in the intensity of ultraviolet radiation in its position as compared with that of the rest of the sky. The sun is only completely invisible for them on very overcast days.

So that what has been said shall not seem too amazing, I shall give some of the results of my own unpublished experiments. Some mounts of the eyes of bumble bees, that are closely related to bees, revealed a contrast sensitivity of 1-2% under electrophysiological experimental conditions. The contrast sensitivity of the eye was even higher (less than 0.5%) in the reindeer warble fly (Oedemagena tarandi L.). Insects can, in fact, see a difference of a few percent in illumination.

Frisch, Lindauer, and Schmeidler, (1960) conclude their work on the way in which bees orientate themselves in overcast weather by referring to the difficulty of giving a physical explanation of the experimental facts. Do ultraviolet rays in fact penetrate better through clouds than the longer wave components down to λ650 mμ, which is the boundary of the visible spectrum for bees? It is known that water vapor in the first instance holds back (diffuses) ultraviolet light.

Astronomical orientation of other insects. Birukow (1956) noted, when studying pond-skaters (Velia currens) in Germany, that when alarmed on the bank (and on dry land in general) the insects always make off to the south. Pond-skaters make off due south at any time of day and have been found to orientate themselves by the sun or by the pattern of polarized light in the blue sky, with allowance for the diurnal passage of the sun in its orbit. Under artificial conditions in a room the insects also follow a definite course relative to the bulb, which they clearly take for the sun. They also behave in a similar way at night if the light is on in the room. But the significance of the reference angles of water skaters relative to the sun (or to a lamp) does not vary in the same way during the day as in bees, but follows a sinusoidal curve. At midday and midnight the angle is 0° (the insect moves towards the sun or the lamp); between mid-day and sunset the angle on the right of the insect increases, while after sunset and up to midnight it decreases (on the same side of the insect); finally, between midnight and sunrise the reference angle increases on the lefthand side of the insect and then decreases until midday. The "clock" of the water skater is regulated by the alteration in the reference angle and reverses at night. At night the sun apparently retraces its diurnal path by this "clock" from west through south to east.

Birukow and Busch (1957) later made use of this innate ability of water-skaters to move due south when they noted that the extent of the alteration in their angle of motion relative to the sun is solely dependent on the duration of the daylight period, and therefore varies gradually from season to season. Thus, if water skaters are kept in the winter under conditions of a short (natural) day which is then artificially increased to the summer length, the insects correct their "southerly" course (relative to the lamp) in these hours of additional light to correspond to the direction to the "south" on a summer day.

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[2] It should not, of course, be forgotten that bees make considerable and even primary use of terrestrial reference points (Frisch and Lindauer, 1954). On first leaving the hive or after it has been moved to a new site, bees look round carefully and in their memory the hive is always located in relation to easily recognizable objects close at hand (buildings, trees, rows of plants, roads, etc).

[3] The type of film used combined with the UG-2 Schott filter made it possible to take photographs in ultra-violet rays only.

The rhythmic alterations in the course of water skaters are soon lost if they are kept in conditions of continual illumination or darkness, even although they were previously maintained at any hour of the day or night. The extent of alteration in angle gradually decreases and they soon maintain a constant course of 0° (i. e. straight towards the light), which probably corresponds to the "stopped position of the clock" when illumination conditions are invariable. It can be shown that the "clock" always stops at mid-day. When illumination conditions are changed (transfer from darkness to light or vice versa) the "clock" starts again, but always in the same direction. This is shown by the fact that the reference angle of the insect always begins to increase on its right (counter to the movement of the sun).

Thus, the rhythm in the orientation of water skaters (the running of the "clock") is exogenously maintained by the continual alternation of day and night, and periods of darkness reverse the process in the central nervous system of the insect. The "clock" can be started simply by an alteration in lighting conditions, whatever the true time. Therefore, when once the "clock" of a water-skater has had its natural rhythm interrupted, it is fairly easy to transfer it to a different rhythm. Within a few weeks, for example, water-skaters can adapt themselves to a 10 hr day with 5 hours of light and 5 hours of darkness.

The following brilliant experiment by Birukow and Busch (1957) provides additional confirmation that 1) the "clock" of water-skaters can be stopped and retarded, but 2) it is impossible to alter the direction, since the "clock" always starts in the direction of the earth's rotation. In the spring water-skaters adapt quite rapidly to a diametrically opposed rhythm of days and nights of equal duration, when a light is turned, in the dark box in the evening and turned off in the morning. If water-skaters used in these experiments are brought out during the day (i. e. during their subjective night) and exposed to the sun or to the polarized light of the sky they move to the north and not to the south. The divergence of 180° in their subjective path to the south by comparison with true south is fully understandable. The reference angles of the water-skaters used in the experiment during their subjective day coincides with the true nocturnal direction of the passage of the sun from west to east through north. This means that all alterations in the course of the water-skaters during the astronomical day are shifted by 180° relative to the actual position of the sun. Therefore, during the subjective night when the experiment was carried out in the open, the sun was moving from east to west through north by the "clock" of the water-skater.

It follows from this experiment that water-skaters can determine the position from the nature of polarization in the blue sky during their subjective night.

It is apparent from the studies of Jander (1957) that ants of the genus Formica orientate themselves in a manner similar to that described above for bees, although the organization of the "ant clock" has still not been discovered. When in motion they are guided both by terrestrial and by celestial reference points. Both celestial reference points (the sun and the pattern of polarization in the sky) are interconnected for them, and they can allow for the passage of the sun through the sky. Ants can remember a direction relative to a source of light for at least 5 days. They can use terrestrial reference points to remember simultaneously the way to several different points to which they have been taught to go for food. They can also remember independently direction in relation to celestial and terrestrial reference points.

In relation to the orientation of insects one must mention an interesting observation by Gusev (1956) on Baykal caddisflies, for which he provided no explanation. In late May, towards midday, a great many pupae of the Baykal caddisflies belonging to the tribe Baicalinini appeared at the surface of the shore ice. They moved with amazing precision, as if by compass, to the shore, ascending the overhanging walls of cracks in the ice or swimming through gaps between it. One pupa, isolated from the rest, reached the shore. It was impossible to divert it from its path by moving it in different directions. It found the correct path even when the coastline could not be seen by man.

It is certain that the caddisfly pupae emerging from the water set course for the shore by the celestial compass and that they have some sort of "clock" that is synchronized with the movement of the sun.

I have previously dealt with less complicated forms of astronomical orientation in insects (based on meno- and tropotaxis — Mazokhin-Porshnyakov 1959).[4]

Orientation of arachnids and crustaceans by the sun, polarization of the sky and the moon. The species of arachnid and crustacean studied have a similar mechanism of astronomical orientation to bees, but their internal "clocks" are different. They are of pendulum type and apparently have a constant (endogenous) "winding mechanism".

Tongiorgi (1959) experimented with wolf spiders (Arctosa) from shallows near Pisa with a sheet of water to the south. On returning from the surface of the water, the spiders move due north in the direction of the shore. They orientate themselves by the sun or by the polarization plane on a patch of blue sky, selecting an angle relative to it that changes in the course of the day. When spiders were kept for three days under light conditions which advanced (or retarded) the natural rhythm by 6 hours, Papi et al. (1955, 1957) demonstrated that these spiders orient themselves to the light of the sun in a different way from the controls: they selected an angle relative to the sun that would have been correct 6 hours earlier or later.

The existence of so simple a cause for phase shift in the rhythm governing the change of angle enabled them to test the orientation of the spider by the sun during its subjective night. In similar experiments Tongiorgi (1959) found that the spider "clock" will function at night, but in reverse. If the natural rhythm of day and night is reversed for three days and the spiders are then used for experiment during the day (their subjective night) their angle of orientation is the same as that of the control spiders but in the opposite direction. During their subjective evening (actual morning) the spiders select the same azimuth as the controls select in the evening; with the sun at mid-day both select the same azimuth and in their subjective morning the spiders used in the experiment select the same azimuth as the control specimens select in the evening. This means that the spiders used in the experiment oriented themselves during their subjective night as if the sun were moving from west to east through south during this time.

The mechanism of orientation in the spiders is greatly disturbed if the experiments are repeated throughout the whole of a subjective night. The spider had to be kept under the new rhythm for not less than 36 hours before its internal "clock" was fully synchronized with the opposite rhythm.

It is a curious fact that the spiders Arctosa variana C. L. Koch and A. cinerea, that live in the immediate vicinity of water, orientate themselves much more precisely when selecting a course to the shore than does A. pirita Latr., which is associated with dunes and lives in parts of the coast removed from the water. This more accurate orientation by the first two species is clearly associated with special features in their mode of life (Papi, 1959).

The astronomical orientation of crustaceans has been studied in detail on Talitrus saltator Mont. (Pardi and Papi, 1952). This species lives in damp sand at the water's edge. If it is taken to dry sand far from the shore it always moves towards the sea. On one occasion crabs from the western coast of Italy were taken to the eastern coast. When they were set down on dry sand near the shore they moved inland, to the west, i. e. in the direction of the sea at home. These crabs orientate themselves by the sun or by polarization of blue sky.

When the pattern of night and day was artificially shifted by 12 hrs in T. saltator (Pardi's experiments, 1954, 1958a) the angle of orientation was reversed during the subjective night by comparison with the controls. The "clock" of a crab runs in the same way during the night as in spiders of the genus Arctosa. By these "clocks" the sun moves backward during the night; from west to east through north.[5]

[4]The study by Jacobs-Jessen (1959) should also be consulted.

[5]The beetle Phaleria provincialis Fauv. is an insect that orients itself by the same "clock" as Arctosa or Talitrus if placed under artificial light at night (Pardi, 1958b).

T. saltator does not lose its ability to orient itself by the sun even after it has been kept in total darkness for many days. It therefore follows that the pendulum "clock" of a crab has a 24-hr movement and that the length of day merely synchronizes the "clock" with the passage of the sun (diurnal and seasonal) but does not start the "clock" as in water-skaters.

The amazing ability of crustaceans to make use of celestial reference points is not restricted to the sun or to polarization of the scattered light of the sky. Papi and Pardi (1959) have established that T. saltator can find the direction of the sea even at night — by the moon. Crabs from the opposite shores of the Appennines move correctly towards the sea during the different phases of the moon and whatever its position in the night sky (but each one does so differently in accordance with its local topography). The majority of the crabs oriented 24 hrs before the experiment or at new moon and kept continually in darkness. Papi and Pardi (1959) assume that T. saltator has two physiological rhythms ("clocks") that enable it to orient itself by the sun and the moon. But it would be able to orient itself by the moon with a solar "clock" alone, if it already knew the pattern of moon rise and moon set and made the necessary adjustment to the solar "clock" every night.

Analysis of polarized light. It has now been established that quite a number of terrestrial and aquatic crustaceans, arachnids and insects can orientate themselves in polarized light.[6] This does not, however, mean that every animal has visual perception of polarization as such. Polarized light can be distinguished from non-polarized light without possessing an intraocular mechanism for the analysis of polarization. Three optical mechanisms are involved in the visual orientation of animals under natural conditions or in experiments with polarized light: an extraocular mechanism and two types of intraocular mechanism.

Type I is an extraocular mechanism, by which the animal takes visual note of the surrounding pattern of brightness due to the nature of the reflection, refraction or scattering of polarized light by the surroundings (the brightness patterns vary in relation to the polarization plane of the light). This mechanism is totally unrelated to analysis of polarization by the eye, but it does allow the animal to react to polarized light. When Diptera, ants and butterflies and moths are illuminated with polarized light, there is only an optical motor reaction to rotation of the polarization plane when the insects are on a black shining surface (Kalmus, 1958). The shining surface only reflects polarized light (shines) in certain areas. The changes in the position of the flashes on rotation of the polarization plane give rise to an optical motor reaction in the insect. It therefore follows, that in these experiments, the insect eye reacted not to polarization per se, but to unevenness in illumination associated with the nature of reflection of polarized light from a non-mat (shining) surface.

Kalmus (1958) went further in his conclusions from these experiments and started an argument that is still in progress. In company with Baylor and Smith (1958) he suggested that in the classical experiments of Frisch and his followers, the bees were reacting during their "dances" not to polarization per se but to the associated brightness patterns (on honeycombs etc.) In fact, in the special conditions of a laboratory experiment (Baylor and Smith, 1958; Smith and Baylor, 1960), the reaction of bees to polarization was exclusively that of an extraocular mechanism.

An extraocular mechanism for analysis of polarization will not, however, explain all the types of orientation to the light of the blue sky found in arthropods. In a paper published in 1960 Frisch (Frisch, Landauer and Daumer) refuted Kalmus's clearly untenable hypothesis (1958) with a pedantry worthy of a true scholar. He showed from observations of "dances" by bees with partly blinded eyes (top half or bottom half) on both mat and shining surfaces, that the "dance" is oriented directly from the polarization plane of the sky and not from any brightness pattern.

The fact that the arthropod eye notices brightness patterns due to the nature of polarization on surrounding objects does not prevent it from reacting to polarization itself. A further example is provided by the experiments of Bainbridge and Waterman (1958) and Waterman (1960) on Daphnia and Mysidium. These crustaceans orient themselves by the polarization plane of light in completely clear, repeatedly filtered water, in which there is practically no light diffusion. If the water is made cloudy with a suspension of yeasts or SiO_2, the orientation of the crabs, and especially Mysidium, is greatly improved for the same conditions of illumination by polarized light. In the latter case these crabs perceive both the direction of the light vibrations and the brightness patterns developed in the turbid medium by different horizontal scattering of the vertical ray of polarized light.

Polarization patterns associated with illumination of the surface of the water by light from the sky are found in the sea under normal conditions in addition to brightness patterns (Waterman, 1954). Marine animals, therefore, also have a real basis for orientation by the polarization plane of light, and do in fact use it (Carthy, 1957; Waterman, 1959).

It follows that invertebrates possess one of two intraocular mechanisms for analyzing polarization, although they may also orient themselves extraocularly in polarized light.

Type II is an intraocular mechanism based on the polarization properties of the rhabdomeres of the optic cells, which form a rosette that can be likened to a radial or concentric polaroid. This hypothesis, which was first advanced by Frisch (1950) and Autrum and Stumpf (1950) (see Mazokhin-Porshnyakov, 1959), has some foundation in the light of later microscopic research on the structure and optic cells (Stockhammer, 1959).

Type III is an intraocular mechanism associated with the nature of the reflection and refraction of rays of polarized light by the diopter apparatus at a certain angle of incidence to the optic axis of the eye (Stephens, Fingerman and Brown, 1953; Baylor and Smith, 1953). This hypothesis states that the shape of the brightness pattern that should develop on the retina of an eye illuminated by polarized light is dependent on the direction of the light vibration. It can be produced firstly by the anisotropy of the cornea (Stockhammer, 1956), secondly by the unequal transparency of the cornea to differently polarized rays, as a result of its shining convex surface and thirdly by reflection of light by the pigmented cells. We are not certain, however, that this pattern is sufficiently intense to be perceived by the optic cells.

There are clearly no decisive facts to support the second or third types of intraocular mechanism. In this I agree with Kalmus (1959), but take issue with the extremely categorical view of Stockhammer (1959) and Frisch, Lindauer and Daumer, 1960), who rely on the isotropy of the crystalline cone of the ommatidium in omitting optic phenomena in the cornea and on its surface from their calculations. Nevertheless, the hypothesis of Frisch (1950) and of Autrum (Autrum and Stumpf, 1950) has the best foundation and provides the simplest explanation of the way in which animals orient themselves by the sun from an isolated patch of blue sky. This explanation is much more complicated in terms of intraocular analysis of the third type.

Electrophysiological data from experiments in which the intracellular potential of an optic cell was recorded in the flies Lucilia (Kuwabara and Naka, 1959) and Calliphora (Burkhardt and Wendler, 1960) in response to rotation of the polarization plane of light are a most weighty argument in support of the idea that the analysis of polarization is made in the optic cells. These authors have shown that the magnitude of the action current in an isolated optic cell is dependent on light intensity and on the position of the polarization plane. Rotation of the polarization plane through 90° alters the amplitude of the action current by 20%. There is the same percentage increase in amplitude if the intensity of the light stimulus is doubled.

CONCLUSIONS

The wide range of experiments conducted by Frisch and his pupils leave no doubt that bees orient themselves by the sun. This is made possible by the existence in bees of memory and of an internal "clock" synchronized

[6] See Mazokhin-Porshnyakov (1959) and Frisch, Lindauer and Daumer (1960) for lists of these species.

with the movement of the sun. They use this "clock" to make corrections to the angle between the direction to their object (nectar supply, new nest) and the sun, thus compensating for the earth's rotation. On Cloudy days bees determine the position of the sun in the heavens either from the nature of polarization in patches of blue sky or (in cases of total cloud cover) by detecting its direct ultra-violet radiation. In addition to orienting themselves by the sun, bees can communicate the azimuth of a path relative to the sun to other bees (by the "dance").

Other insects (Velia, Formica and caddisflies), and spiders (Arctosa) and crustaceans (Talitrus), orient themselves by the sun and by polarization of the light from the sky, but, with the possible exception of the ants, their internal "clocks" are different: the "hand" of these "clocks" fluctuates like a pendulum with a 24-hr period. The "hand" of the apian "clock" completes a full revolution in the same time.

Arthropods have two ways of orienting themselves in polarized light: from the specific brightness patterns on surrounding objects (extraocular analysis of polarization) or directly from the polarization plane (intraocular analysis). Intricate forms of orientation (bees and spiders) by the light from the blue sky can apparently be explained solely by intraocular analysis on the basis of the polarizing properties of optic cells.

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HOST SPECIFICITY AND ADAPTATION TO NEW HOSTS IN APHIDS (HOMOPTERA, APHIDOIDEA) IN THE PROCESS OF NATURAL SELECTION (EXPERIMENTAL RESEARCH)

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Most aphids are narrowly specialized to one host and are found on only one genus or even one species of plant.[1] There are various reasons for this. The leg and caudal structure, for example, is adapted to a particular kind of surface (Mordvilko, 1901, 1934). The main factor, however, is food specialization, the importance of which has been indicated by many authors (Mordvilko, 1921; Börner, 1952; Shteynberg, 1955 and others). Aphid host specificity is very persistent and has long served as an important criterion for the differentiation of otherwise similar species. Despite this narrow specialization, however, change of host is widespread both as a phylogenetic and as an ontogenetic phenomenon in aphids, which have often transferred or will transfer as individuals to new hosts taxonomically and ecologically remote from their former hosts.

Problems of form and species formation and plant resistance are closely connected with change of hosts. It is therefore of general interest to study the conditions under which adaptations to new hosts occur in narrowly specialized species and to investigate the consequent changes in specialization, particularly since these problems have been neglected in relation not only to the aphids but also to phytophagous insects in general. Unfortunately very few attempts have yet been made to produce experimental adaptations of the insects to new plants. The most interesting, perhaps, of such experiments have been left without a follow-up covering a large number of generations (Kozhanchikov, 1941, 1958; Smirnov and Chuvakhina, 1953).

The starting point of the research described here was provided by applying to aphids Ye. N. Pavlovskiy's views (1946) on the way an organism becomes a host to the aphids (Shaposhnikov, 1951, 1955). Pavlovskiy showed that in nature there exist potential hosts; that is, organisms which, although not the hosts of a polyphagous parasite, are morphologically, physiologically and biochemically suitable for the progress of its life cycle on or in them. The prerequisite for turning the potential host into an actual one is a favorable combination of biocenotic and ecological factors that will make it possible for the parasite to encounter its host in circumstances making for indirect parasitization. On transferring to the potential host, the parasite does not need to adapt to it in order to survive, since the new habitat happens to be already entirely suitable. This random favorable coincidence of parasite and host characteristics of independent origin provides the material for subsequent evolution.

Like most other aphid species, the forms studied were narrowly specialized as to hosts, and can be properly classified as monophagous. It is improbable that these insects had potential hosts already suitable for colomization. Indirect parasitization on the new host would obviously involve adaptation of the aphid to a new medium. In this paper, therefore, we shall include under the term "potential hosts" plants which although previously unsuitable can, under certain conditions, be appropriated as new hosts.

Pavlovskiy was mainly concerned with the suitability of hosts for appropriation by polyphagous parasites. In the work described here, however, we have studied not only this aspect of the question but also the adaptability of monophagous parasites for the acquisition of new hosts.

[1] By parasite specialization we understand the capacity of the parasites (their potentiality) to live on a definite group of hosts. This is manifested in the frequency of occurrence, which is always narrower than the specialization (Bykhovskiy, 1957).

This paper is the second link in a study undertaken by the author on the subject of aphid host exchange, its reasons and origin (Shaposhnikov, 1959) and its role in aphid evolution.

MATERIAL AND METHODS OF INVESTIGATION

The material investigated consisted of similar forms of dioecious aphids of the subgenus Dysaphis CB, s. str. The observations and tests were performed in 1954-1957 at the Shuntuk farm near Maykop in the North Caucasian foothills and were continued in Leningrad in 1958.

In the Maykop area aphid migration from the primary hosts (Malus orientalis Uglitz., M. domestica Borkh.) is as follows: Dysaphis anthrisci majkopica Shap., subsp. n.[2] to Anthriscus nemorosa MB., D. anthrisci chaerophyllina Shap. to Chaerophyllum maculatum Willd., D. brachycyclica Shap. sp. n.[3] to Chaerophyllum bulbosum L., D. radicola Mordv. to Rumex obtusifolius L., R. crispus L. and R. stenophyllus Ldb.

A fuller description of the material, along with a general discussion of methods, has been given in the previous paper (Shaposhnikov, 1959).

To cause the aphid to transfer to a new, previously unsuitable host, Smirnov and Chuvakhina (1952) alternated two food plants day by day: the old host, suitable for the aphid culture; and the new one, which was unsuitable. Our method was to seek random favorable combinations of the individual characteristics of the parasite and of the host adopted by it. The alternation method was used only as a supplementary technique and to a negligible extent.

[2] Differentiated from other subspecies (anthrisci CB, s. str. chaerophyllina Shap., bunii Shap.) by the longer cornicles (0.21-0.37 mm), which are 4.5-6.2 times longer than their median diameter, the cauda (0.163-0.192 mm), which is 1.34-1.57 times longer than the 2nd segment of the hind tarsus without the claws and by the strong sclerotization of the apterous sexuparae (transverse bands are sometimes present on all the body tergites).

[3] Differentiated from the similar species (chaerophylli CB, s. lat.) by the shorter hairs (the longest hair on the 3rd antennal segment is 0.026-0.042 mm, equal to 1.2-1.9 of the diameter of this segment in its narrow part and the marginal hairs on the 3rd abdominal tergite are 0.039-0.055 mm long, equal to 1.9-2.6 of the diameter of the 3rd antennal segment), by the presence of marginal tubercles on the 6th abdominal tergite, and the curtailed life cycle, which ends in summer. Differentiated from anthrisci CB, s. lat. not only by the presence of marginal tubercles on the 6th abdominal tergite but also by the greater number of hairs (5-9) on the 8th abdominal tergite. The fact of remigration has been only experimentally established; the migration of this species from apple is therefore only hypothetical.

All the main tests were made with pure aphid cultures, that is, isolated clones (the progeny of a single fundatrigenia).

Migrantes of a single clone (as a rule 10 individuals) had the possibility of selecting plants suitable for them from a whole assembly of secondary hosts growing in a single bowl: Anthriscus nemorosa, Chaerophyllum maculatum, Ch. bulbosum and one of the Rumex species. Sisters of these aphids (as a rule 10 migrantes) were then offered only the new hosts, either one at a time or in the form of four plants of one species at a time. The four plants of a single species were taken from situations differing as regards soil and microclimatic conditions.

The transfer of the third and later generation aphids from the old host to the new was performed, in the main experiments, in each generation aphids from the old host to the new was performed, in the main experiments, in each generation; 10 adult aptera and 15 first-instar larvae at a time being transferred as a rule. In the supplementary experiments the numbers were usually considerable, often 100 individuals at a time, collected from various situations.

A few of the clones in which the progeny of the migrantes survived best on the new host were subdivided into a series of repetitions: 3, sometimes 2 on the old (control) host; and from 3 to 10 on the new host.

In November 1957 the experimental aphids (parthenogenetic non-holocyclic lines) were transferred to Leningrad, where they continued to reproduce on Ch. maculatum and Anthriscus nemorosa MB. brought in for the purpose; on 23 June 1958 A. nemorosa was replaced by the Leningrad A. silvestris Hoff.

The eggs produced in 1957 as a result of mating under isolators (normal holocyclic lines) were preserved in a refrigerator in test-tubes plugged with fresh sphagnum moss. The fundatrigeniae hatched from these eggs (on apple under isolators on an experimental plot in Leningrad) produced migrantes which were also used in the experiment.

Section 1. Frequency of aphid occurrence in nature.

In the Maykop district the aphids were distributed on the primary and secondary hosts as follows:

	Percentage of 91 clones isolated on apple trees	Percentage colonizing secondary host
a. majkopica	66.7%	15.5%
a. chaerophyllina	28.4%	8.6%
radicola	4.9%	27.6%[4]
brachycyclica	0.0%	36.7%[4]

Under various ecological and biocenotic conditions, particularly in mixed grass stands consisting of growths of Ch. maculatum, Ch. bulbosum and Anthriscus, many hundreds of individuals of the secondary hosts of these aphids were inspected. Aphid colonies were collected from 88 Anthriscus plants, 83 Ch. maculatum plants, 191 Ch. bulbosum plants, and 63 Rumex plants; yet there was not a single instance in which aphids were detected on an alien host, i. e, on a plant species not specified to them.

On the other hand, a number of investigators have reported entirely plausible discoveries of more or less prolonged colonization, by narrowly specialized aphid species, on plants not natural to them (Hille Ris Lambers, 1938-1953; Shaposhnikov, 1951; Börner, 1952; Bozhko, 1953; Wood-Baker, 1953 and others).

On apple, a. majkopica usually predominated in "its own" situation, that is, near growths of Anthriscus and a. chaerophyllina near growths of Ch. maculatum; but one or the other form was often found on apple in an "alien" situation.

Observations on many trees, both of Malus orientalis and of Malus domestica throughout four springs showed that some of the trees were colognized by aphids year after year, others irregularly and yet others not at all. By numerous tests in which fundatrigeniae were transferred, it was convincingly demonstrated that normal development and reproduction were quite possible on the uncolonized trees.

As a rule, trees growing in the deep forest, particularly among dense undergrowth, were not infested or only very slightly; trees on the edge of the forest were more heavily and more frequently infested, and trees standing alone were the most heavily infested of all. Old trees with rugged bark were more heavily infested, and younger trees less heavily.

Section 2. Aphid specialization in the experiments.

Since for reasons of space it is impossible to give figures on all four of the aphid forms studied, it will be best to confine ourselves to a. majkopica and a. chaerophyllina (Tables 1 and 2) and to indicate our general conclusions.

1. Under the experimental conditions the aphids fed and reproduced on new hosts not characteristic of the form in question. Thus, in Ch. bulbosum, a. majkopica fed in 49 out of 123 experiments and reproduced in 41 of them; while a. chaerophyllina fed and reproduced in all 45 experiments. Similarly, on Rumex, a. majkopica fed in 13, and reproduced in 7 out of 86 experiments; and a. chaerophyllina fed in 15, and reproduced in 13 out of 43 experiments.

2. On the other hand, a. majkopica did not reproduce once in 159 experiments on Ch. maculatum, and fed on it in only 10 experiments; and a. chaerophyllina, during a short time on Anthriscus, fed in only 9 and reproduced in only 4 out of 96 experiments. Neither brachycyclica nor radicola reproduced on these two plants.

3. The aphids fed and reproduced on the new hosts, in the absence of the old host, more often than in the latter's presence; in the presence of several individuals of the new host (possibility of selection), they fed and reproduced more often than when only one individual was available.

4. There were more instances of feeding and reproduction on alien hosts in the case of migrantes than of aphids belonging to the succeeding 3rd and 4th generations, and more in the case of these generations as compared with later generations in general, even though a large number of individuals taken from different clones were used in the experiments with late generations, so as to increase the chances of transfer to a new host.

Section 3. Trophic adjustment to a new, unsuitable plant in D. a. chaerophyllina Shap.

In the experiments with a. chaerophyllina on an alien host, Ch. bulbosum, the aphids invariably fed and reproduced even in the presence of their own host (Sec. 2); yet in nature this aphid was found only on its own host even in mixed grass stands with a predominance of the alien host (Sec. 1).

In experiments with clone 0203 on 13 May, 10 migrantes were transferred to a number of secondary hosts, where they adapted to Ch. maculatum, and then in 2-4 control tests produced 47 generations on this plant up to autumn 1958.

On 8 June, 15 4th-generation aptera were transferred from the control to Ch. bulbosum, where they reproduced in 3-5 repetitions. To preserve the line the aphids were then transferred from one Ch. bulbosum plant to another, 21 times in all. Up to the 8th generation inclusive the vitality[5] of the aphids was unstable (mainly in the sense

[4]The heavy infestation of the secondary host, following a slight infestation of the primary host is due mainly to the presence in radicola and brachycyclica of a large number of migrantes from the 4th and later generations.

[5]The sense in which "vitality" is used here covers all such meanings as survival power, fertility, rate of growth
---(Footnote continued on next page) ---

Table 1

Results of transferring Dysaphis anthrisci majkopica Shap. to plants not characteristic of it

Host plant	Aphis	Migrantes				Aptera and 3rd-4th generation larvae				Aptera and 5-12th generation larvae			
		No. of experiments performed	Number of clones used	Percentage of experiments in which		No. of experiments performed	Number of clones used	Percentage of experiments in which		Number of experiments performed	Number of clones used[1]	Percentage of experiments in which	
				Aphids fed	Progeny in turn reproduced			Aphids fed	Progeny in turn reproduced			Aphids fed	Progeny in turn reproduced
Ch. bulbosum	with others	31	31	51.6	9.7	—	—	—	—	—	—	—	—
	one individual separately	15	14	60	26.6	25	24	28	8	41	16	14.6	2.6
	four individuals separately	6	6	100	83.3	5	5	100	20	—	—	—	—
Ch. maculatum	with others	42	42	4.8	0	—	—	—	—	—	—	—	—
	one individual separately	24	14	0	0	54	40	11.1	0	28	14	3.6	0
	four individuals separately	10	10	10	0	1	1	0	0	—	—	—	—
Runner	with others	39	39	10.2	0	—	—	—	—	—	—	—	—
	one individual separately	2	1	0	0	34	34	8.8	5.9	6	4	33.3	0
	four individuals separately	3	3	66.6	33.3	2	2	100	50	0	—	—	—

[1] Includes aphid colonies taken from individual plants in nature.

that there were sharp variations in the mortality rate) but it was later restored. The last Ch. bulbosum plant (annual) in the experiment died on 26 August, along with 11th and 12th generation aphids.

and development; in other words, everything that influences population increase. Lowered vitality is as a rule accompanied by reduction in the size and weight of the aphids; the converse is also true.

In a number of generations the aphids were transferred from Ch. maculatum to Ch. bulbosum and vice versa and in all cases adapted to the new host (Table 3).

As we see then, after 4 generations had adapted to the new host (Ch. bulbosum), a. chaerophyllina had become completely adjusted to this host, although even after 8 generations these aphids had not lost their ability to live on their own old host, Ch. maculatum.

Table 2

Results of transferring Dysaphis anthrisci chaerophyllina Shap. to alien plants

Host plant	Aphis	Migrantes					Aptera and 3rd-4th generation larvae					Aptera and 5-12th generation larvae				
		No. of experiments performed	Number of clones used	Percentage of experiments in which			No. of experiments performed	Number of clones used	Percentage of experiments in which			Number of experiments performed	Number of clones used[2]	Percentage of experiments in which		
				Aphids fed	Aphids also reproduced	Progeny in turn reproduced			Aphids fed	Aphids also reproduced	Progeny in turn reproduced			Aphids fed	Aphids also reproduced	Progeny in turn reproduced
Ch. bulbosum	with others	32	29	100	100	—[1]	—	—	—	—	—	—	—	—	—	—
	one individual separately	—	—	—	—	—	—	—	—	—	—	13	15	100	100	77
Anthriscus	with others	27	27	3.7	3.7	0	—	—	—	—	—	—	—	—	—	—
	one indiv. separately .	18	9	16.6	11.1	0	37	27	2.7	0	0	10	2	20	0	0
	four individuals separately	4	4	50	25	0	—	—	—	—	—	—	—	—	—	—
Rumex	with others	26	26	7.7	7.7	0	—	—	—	—	—	—	—	—	—	—
	one indiv. separately .	1	1	100	100	0	28	26	7.1	3.6	0	1	1	100	0	0
	four individuals separately	11	8	81.8	81.8	0	2	2	100	100	0	—	—	—	—	—

[1] The subsequent fate of the migrantes' progeny on Ch. bulbosum was traced only in one clone (No. 0203), in which the aphids successfully reproduced.

[2] Includes aphid colonies taken from individual plants in nature.

Section 4. Adaptation of D. a. majkopica Shap. to new, previously unsuitable plant.

It was found from the experiments that Ch. maculatum was not a suitable host for a. majkopica; in no case did the aphids reproduce, and only in a few cases did they feed on this plant. Ch. bulbosum, on the other hand, can act as host, at least for a time (Sec. 2), as is further shown by the special tests made with clones 3812 X 3823 (1955), 0186 (1956), 0195, 0197 and 0205 (1957), in which the aphids produced a number of generations on this plant.

In experiments with clone 0197 on 19 May, 13 migrantes were transferred to an assembly of secondary hosts, where they adapted to Anthriscus. The aphids then reproduced on this plant in two repetitions (control) up to autumn 1958.

On 21 May, 9 migrantes (sisters of the control insects)

were transferred to 4 Ch. bulbosum individuals. The aphids at first adapted to two and then to only one of the plants. After 6 June the experiment was reproduced, at first three times and then up to eight times. The aphids were transferred 40 times to new Ch. bulbosum plants represented by 1, 2 or 3 individuals at a time. On the 1st and 5th repetitions the aphids were transferred for a day to Anthriscus in order to restore their exhausted vital capacity. Up to the 7th generation inclusive, their vitality was extremely unstable; this mainly took the form of frequent, unexpectedly sharp variations in fertility and mortality. Owing to the termination of the Ch. bulbosum (annual) life cycle, the last dying specimens of this plant and of the aphids (brachycyclica) living on it were observed in nature on 16 August. In the laboratory, a majkopica lived until 20 August, and perished in the 11th generation.

In each generation. Starting with the 3rd, 4th and 5th, aphids were transferred from Ch. bulbosum to Ch. maculatum and also to Anthriscus and back again (Table 3). By the 5th and 6th generations the insects had lost their capacity to transfer from Anthriscus to Ch. bulbosum. This was observed also in the experiments with clones 3812 X 3823, 0186, 0195 and 0205.

Up to the 7th generation inclusive, the aphids reared on Ch. bulbosum transferred readily to Anthriscus; the same occurred in a similar experiment with clone 0186. From the 8th (apterus) and 11th (larval) generations onwards, however, the aphids lost their capacity to reproduce or even to feed on Anthriscus. On all the Anthriscus individuals (which had young shoots, favored by the aphids) to which the aphids reared on Ch. bulbosum did not adapt, 10th generation female siblings transferred from other Anthriscus individuals out of the control group, readily adapted.

Up to the 7th generation inclusive, the experimental aphids neither fed nor reproduced on Ch. maculatum. In the 8th and 9th generations, they proved capable of feeding on this plant (in clone 3812 X 3823, to the 7-8th generation; and in the 10-11th generation, they also reproduced normally).

Aphids reared on Ch. bulbosum (intermediary) thus transferred to Ch. maculatum in the 10-11th generations, where they then normally reproduced for more than a year.

All attempts to transfer a. majkopica directly from Anthriscus to Ch. maculatum were unsuccessful (Sec. 2 and Table 3), excepting 1. On 22 August 1958, of 30 first instar larvae of the 48th generation, 1 adapted to a dystrophic Ch. maculatum plant growth in the laboratory in Leningrad from rootstocks sent from the Maykop district. Up to the 48th generation, the aphids were reared over 14 months in the laboratory under inconstant temperature and light conditions, on Anthriscus nemorosa up to the 41st generation, and then on Anthriscus silvestris. In general, it should be noted that after prolonged rearing in the Leningrad laboratory the aphids started to feed and, in due course, to reproduce on alien hosts much more often than was observed during the first period of rearing in the Maykop district under conditions closer to nature.

As Table 4 shows, fertility and the rate of development in a. majkopica altered with adaptation to the new host, approximating to those of a different subspecies.

To summarize: a. majkopica, as a result of living through 8 generations on an unsuitable plant (Ch. bulbosum) adapted to it and at the same time lost its capacity to live on its old host (Anthriscus) and acquired the capacity to live on a new, previously quite unsuitable plant, Ch. maculatum.

Section 5. Species, variety and clone susceptibility of hosts.

The hosts of a. majkopica (Anthriscus) and a. chaerophyllina (Ch. maculatum) belonging to the family Umbelliferae. In the experiments, however, both forms fed much more often and multiplied more often, and for longer, on Rumex, of the buckwheat family, than did a. majkopica on Ch. maculatum or a. chaerophyllina on Anthriscus.[6]

It is characteristic that not only a. majkopica but also brachycyclica, whose host belongs to the same genus as Ch. maculatum, completely failed to reproduce on that plant. On the other hand, Ch. bulbosum is more or less suitable both for a. caerophyllina and also for a. majkopica.

Rumex and Ch. bulbosum are thus more readily adopted by many clones of different species of the aphids studied than Anthriscus and Ch. maculatum (Sec. 2), and in this respect these plants can be regarded as more or less universally susceptible, while Anthriscus and Ch. maculatum are universally resistant.

Similar results were obtained when 3 species of aphids of the genus Therioaphis Walk. were studied (Peters and Painter, 1957). The grape variety cinerea Arnold proved universally resistant in 8 biotopes of the grape Phylloxera. The same was true to a lesser extent in the case of rupestris du Lot, and certain others; whereas rupestris Geisenheim 187, Chass. X Berl. M. G. 41 B and others were universally susceptible (Gollmick, 1958). Certain species and varieties of plants proved universally susceptible or universally resistant, not only to various aphid species, but also to insects of different groups (Painter, 1953).

Not only species and varieties, but also individual clones of the same species, and even of the same plant variety, differed in susceptibility to aphid infestation. Of 5 clones of a resistant variety of the lucerne "Lahontan", for example, 3 proved highly resistant to Therioaphis maculata Buckt., and the aphids perished on them within 48 hours; yet 2 clones were relatively susceptible, and the aphids reproduced on them more or less normally, although in general much less successfully than on the susceptible varieties (Howe and Smith, 1957).

It may be that in some cases clone resistance is due to an elaborated immunity. The clonal progeny of the vine variety "Sereksiya", which had not previously been infested with Phylloxera, proved much less resistant in experimental testing than that of vines of the same variety which had previously been infested with the insects for a long period (Zotov, 1955).

Just as polyphagous parasites can adapt to new hosts more readily than the monophagous kinds, so too can universally susceptible plants acquire new parasites or phytophages more readily, in general, than universally resistant plants.

Section 6. Individual susceptibility of hosts.

In experiments on a new host, or in nature on an old host, the aphids did not colonize by any means on all individual plants, but concentrated on a few. They were unable to live at all on many individuals of the new host, although outwardly these plants differed in no way from those which proved suitable.

The aphids adapted to weak plants — plants which had only recently germinated, those which had not yet strengthened, those grown under hothouse conditions, etiolated and dystrophic plants and those affected with rot (Kennedy, 1951, 1953) or virus infections — more readily than to stronger ones.

Plant susceptibility to aphids undoubtedly depends on the plant's physiological condition (Rubtsov, 1952; Kennedy, 1953), and this in turn depends on the chemical composition of the soil (Davidson, 1925; Prints, 1935; McGarr, 1942, 1943; Haseman, 1947; Avant and Jones, 1951; Bobinskaya, 1953; Chesnokov, 1953; Barker and Tauber, 1954; Wilde 1957), on the age and seasonal variations of the whole plant or its individual organs (Kennedy and Booth, 1951, 1954; Shaposhnikov, 1959), on the microclimate and so forth.

Phylloxera-resistant varieties of grapes, for example, became susceptible if they were cultivated under hothouse conditions with abundant moisture or in shade (Schneider — Orelli, 1923; Kostik, 1957). Under these conditions,

[6]The fact that a plant taxonomically remote from the real host proved more susceptible is not unique. Aphids transfer from woody to herbaceous plants which are almost invariably taxonomically remote from their original hosts; very similar aphid species are often specialized to taxonomically remote hosts, and there are known cases of the temporary inhabitation by narrowly specialized aphid species on plants taxonomically remote from their hosts.

--- (Footnote continued in next column) ---

Table 3

Results of transferring Dysaphis anthrisci majkopica Shap. (clone 0197) and D. a. chaerophyllina Shap. (clone 0203) from old host to new and back. (Numerator – number transferred; denominator – number of aphids which produced progeny capable of further reproduction)

Clone No.	Transferred from	Transferred to	Type of individuals	1957 June 3	June 4	June 5	June 6	July 7	July 8	July 9	August 10	August 11
				Aphid generations								
0197	Anthriscus	Ch. bulbosum	Apterous adults	—	10/4	10/0	10/0	10/0	10/0 10/0	—	—	—
			First instar larvae	—	—	15/1	15/0	15/0	15/0	15/0 15/0	—	—
	Ch. bulbosum	Anthriscus	Apterous adults	17/15	8/6	10/8	10/9	10/9	10/0	10/0	10/0 10/0	10/0
			First instar larvae	—	—	18/11	15/10	15/12	15/12	15/7	15/5	10/0 10/0 10/0 10/0
	Ch. bulbosum	Ch. maculatum	Apterous adults and some late-instar larvae	—	—	20/0	7/0	10/0	4/0	—	—	10/6
			Larvae of various instars, mainly early	—	—	65/0	12/0	10/0	24/0	32/0	55/45	
	Anthriscus	Ch. maculatum	Apterous adults	—	—	—	—	—	13/0	—	—	10/0 10/0
			First instar larvae	—	—	—	—	—	—	10/0	—	—
	Ch. maculatum	Anthriscus	Apterous adults	—	—	—	—	—	—	—	—	5/0
			First instar larvae	—	—	—	—	—	—	—	—	—
0203	Ch. maculatum	Ch. bulbosum	Apterous adults	—	15/11	—	10/10	10/8	10/1	10/2	—	—
			First instar larvae	—	—	—	—	15/8	15/2	15/5	15/7	—

Table 3 continued

September				1958[1] June					1958[1] August					1958[2] 23 July	
Aphid generations															
12	13	14	15	37	38	39	41	42	43	44	45	47	48	17+6	17+7
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/0	10/0	10/0	—	—	—	—	10/0	—	—	—	—	10/0 10/0	—	10/0 10/0	—
15/0 15/0	15/0	15/0	15/0	—	—	—	—	10/0	—	—	—	—	15/0 15/1	—	15/0 15/0
10/0	10/0	—	10/0	10/0	10/0	—	—	—	10/0 10/0	10/0 10/0	—	—	—	—	—
15/0 15/0 15/0	15/0	15/0	—	—	15/0	10/0	—	—	—	15/0 15/0	15/0 15/0	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 3 continued

Clone No.	Transferred from	Transferred to	Type of individuals	1957 June 3	June 4	June 5	July 6	July 7	July 8	August 9	August 10	August 11
				Aphid generations								
0203	Ch. bulbosum	Ch. maculatum	Apterous adults	—	5/2 5/1 5/5	10/3	—	23/21	—	10/8	—	5/5
			First instar larvae	—	—	—	15/2	—	10/10 15/7	15/7	15/10	—
	Ch. maculatum	Anthriscus	Apterous adults	—	—	—	—	—	12/0	—	15/0	—
			First instar larvae	—	—	—	—	—	—	50/0	—	—
	Ch. bulbosum	Anthriscus	Apterous adults	—	—	—	—	—	—	—	11/0 10/0	10/0 10/0
			First instar larvae	—	—	—	—	—	—	—	—	20/0 10/0

the amount of non-protein nitrogen in the plant was observed to increase, and the tannine content to decrease. This was apparently due to the normal feeding of Phylloxera (Kostik, 1957).

Individual plant susceptibility is thus closely connected with the conditions of growth, and is exceptionally important in the acquisition of new hosts by aphids.

Section 7. Potential polyphagy in monophage aphids.

In particular aphid clones, the aphids transferred to slightly different varieties of the new host in the initial and subsequent transfers; in most other clones, they did not transfer at all. This indicates an obvious disparity among the clones as regards adaptability. Strictly speaking, all clones in which it was possible to produce adaptations to new hosts can be regarded as potentially polyphagous (Shaposhnikov, 1955). These clones possess relatively broad physiological adaptability, great plasticity or what Michurin called instability.

It should be emphasized that not all individuals in potentially polyphagous clones could adopt a new host. In the experiments, some individuals perished without making the attempt; others perished after a short or long period of effort; and still others reproduced after a time, although their progeny perished at one stage or another; and finally, a fourth group produced progeny which matured and became capable of further reproduction.

Of four Rhopalosiphon maidis Fitch biotypes capable of living on a susceptible variety of sorghum, only one proved capable of feeding and reproducing on the resistant variety as well (Pathak and Painter, 1958). There are other known indications that clones, lines, biotypes and micropopulations of aphids are not equivalent in their relationship to food plants (Prints, 1937); Börner and Schilder, 1939; Harrington, 1943, 1945; Dahms, 1948; Gollmick, 1958; Müller, 1958).

What are the reasons for the appearance of potentially polyphagous aphid clones in nature?

In the case of a. majkopica, after 8 generations of life on an intermediary plant, almost all individuals (51 out of 65) were able to adopt a previously unsuitable host. The same thing happened after 47 generations of life under laboratory conditions of varying temperature and light, when two species used their own hosts in one of four experiments and one out of 50 individuals of this subspecies was also able to adopt a previously unsuitable host (Sec. 4).

Prints's experiments (1937) with the vine Phylloxera are also noteworthy. After only one generation of life on the variety Rip. X. Rup. 3309 (intermediary plant), the biotype "vastatrix" acquired the ability to form galls on Berland. X Rip. 5 BB, which is resistant to direct transfer of aphids from rupestris du Lot.

In experiments performed by Getsova and Lozina-Lozinskiy (1955), first-instar larvae of the gypsy moth refused to feed on pine cones immediately after hatching, or after feeding on a plant of one species — for example, oak or bird cherry — and perished. After a two-day diet on mixed food — for example, oak mixed with bird cherry (intermediary) — they did feed on pine cones, and passed on to the next instar.

All these data indicate that one reason for the occurrence of potentially polyphagous clones can be the prolonged effect of changes in the conditions of life, particularly the trophic conditions.

Table 3 continued

1958[1]														1958[2]	
September				June					August					23 July	
Aphid generations															
12	13	14	15	37	38	39	41	42	43	44	45	47	48	17+6	17+7
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/0	—	—	—	10/0	—	—	—	10/0 10/0	—	—	—	—	—	—	—
10/0	—	—	—	—	15/0	—	—	—	15/0 15/0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[1] Sexuparal reproduction on secondary hosts was not interrupted after May 1957 (artificially anholocyclic).

[2] Sexuparal reproduction on secondary host after 17th generation interrupted from October 1957 to July 1958 by amphigonous generation, overwintering in egg stage and development of fundatrigeniae and migrantes on apple (normally holocyclic).

There is no doubt that potentially polyphagous clones and individuals are foremost in the adoption of new hosts.

Section 8. The adaptability of aphids of various cyclical and ontogenetic stages.

For aphids, the possibility of feeding and breeding on an unaccustomed plant (Sec. 2) decreases from generation to generation from the spring onwards, as does their mortality on their own host (Table 5). The aphids presumably adopt their own secondary host anew each year, gradually becoming more adjusted to it, and thereby narrowing their own adaptability.

Wingless a. majkopica adults had lost their ability to revert to the old host by the 8th generation, whereas the first-instar larvae lost this ability only in the 11th generation (Table 3). A similar picture was observed by Kozhanchikov (1941) in experiments with the leaf beetle Gastroidea viridula Deg. The reason may be that the first-instar larvae are much better material for natural selection, and much less its result than adult individuals. It is hardly surprising that individuals adapted to the old rather than to the new host are found for a longer period among the larvae than among the adults.

It is also noteworthy that, once the plant starts to shrink or wilt, the adult aphids are the first to leave it. These differences between adults and larvae puts them on an unequal footing as regards adaptability to new hosts.

Section 9. The role of natural selection in the origin of adaptations and changes of specialization.

The fertility and growth rate of similar forms of aphids (Table 4), along with their mortality rate (Table 5), when the insects were reared for a long time on one plant species, reached a definite, more or less uniform, level peculiar to the aphids inhabiting the plant species concerned. This level correlates with the non-protein nitrogen level, which is twice as high in Anthriscus (a favorable factor) as in Ch. maculatum (Shaposhnikov and Yeliseyev, 1961).

As can be seen from Table 5 and the graph, the average aphid mortality from a variety of causes, most of them unknown, was small both on the old host and on the new after its adoption, and corresponded to the level peculiar to aphids normally inhabiting the given plant; whereas the mortality on the new host during its adoption was quite high. Since the insects were reared under identical conditions on the old and on the new host the discrepancy should not be attributed to unknown causes, but rather to the extinction of the larvae least well adapted to the new food; in other words, to natural selection.[7]

The figures show that natural selection operates intensively only under altered environmental conditions during the period of adaptation to them; under more or less stable, customary conditions, it operates either not at all or very slightly. It may well be that evolution is a process of alternating brief periods of intensive change with long periods of slight change (relative quiescence, stabilization). Such views were expressed by Darwin (1939 Russ. ed: 157, 164) and other investigators (Smirnov and Samokhvalova, 1954; Ushakov, 1959 and others).

[7] Unfortunately, I have not sufficient data to demonstrate the mortality of adult aphids which had failed to leave progeny in these experiments. Moreover, only lines with relatively high fertility had any real chance of survival and there were very few of these. The figures given here give therefore only a partial picture of the effect of natural selection.

Table 4

Fertility and rate of development of aphids on various plants

	Fertility in September 1957			Mean rate of development of one generation (days)	Number of generations by end Sept. 1958
	Peak	Average	Mean diurnal		
a. majkopica on Anthriscus (0197)	90	69.7	3.4	9.8	51
a. majkopica on Ch. maculatum (0197)	55	36.6	2.1	10.7	47
a. chaerophyllina on Ch. maculatum (0203)	65	53.1	2.5	10.9	46

Table 5

Average mortality rate of larvae (in percentages of total number of hatched) on various plants

	a. majkopica (clone 0197)				*a.* chaerophyllina (clone 0203)		
	Generation	Anthriscus (control)	Ch. bulbosum	Ch. maculatum	Generation	Ch. maculatum (control)	Ch. bulbosum
During adoption of new host — Ch. bulbosum	4—8	6.0	60.4	100.0	5—8	22.5	63.8
First period after adoption of new host	9—11	4.2	5.0	20.0	9—10	13.2	18.6
Subsequent period of rearing	12—47	5.1	—	12.09	12—47	12.17	—

It is generally believed that adaptation to an entire complex of environmental conditions takes place all at once. This is true only in the most general sense. When environmental conditions change, one factor or another invariably exerts the decisive influence, and determines the direction of adaptation and the rate of selection. With a change of latitude, for example, temperature is most likely to be such a factor; with a change of host, the diet or the nature of the surface will probably be more important, and so forth.

In a. chaerophyllina adaptation took the line of improving the use of a food which, although new, was already more or less suitable. Natural selection therefore operated at a relatively slow rate, and for a relatively short time: an average of 41% of the larvae were eliminated in the course of 4 generations. As a result the depth of adaptation was also limited, and although the aphids adopted a new host they retained their capacity to live on the old host (Sec. 3).

A similar picture — the adoption of a new food plant in the course of natural selection, with retention of the capacity to feed on the old plant or even to prefer it — was observed in the greenhouse aphid Neomyzus circumflexus Buckt. (Smirnov and Chuvakhina, 1952, 1953), and in the leaf beetles Gastroidea viridula Deg. and Galerucella lineola F. (Kozhanchikov, 1941, 1958).

The blanket term trophic adjustments could be applied to such cases. In many equally polyphagous lepidoptera, hereditarily strengthened association with a particular food occurs without natural selection even in the 1st generation (Kuznetsov, 1952). In oligophages, close association of this kind occurs only after several generations (Takata, 1959), but apparently also without the operation of selection. These and many other similar cases (Sladden, 1934; Hewer, 1938; Bychenkova, 1957 and others) would be more suitably called trophic preference.

In a. majkopica, adaptation was in the direction of the adoption of a new, previously very unsuitable food. The rate and duration of natural selection were considerable in this case: an average of 53% of the larvae were eliminated within 6 generations. As a result, the depth of adaptation was also great: at the same time as the aphids adopted a new, previously unsuitable host, they lost the capacity to live on the old host, and acquired the capacity to live on yet another new, previously completely unsuitable, plant.[8]

An arbitrary experiment with grape Phylloxera (viteus vitifoliae Fitch) is of exceptional interest. In the middle of the last century, two forms of Phylloxera were brought into Europe from North America: P. v. vitifoliae Fitch (= Phylloxera vastatrix Planch.) with varieties of Vitis labrusca from the eastern states and P. v. vulpinae CB (= Phylloxera vitifolii CB et auct. non Fitch) from Georgia and Missouri with wild vines, particularly with Vitis vulpina (= riparia) (Börner, 1952). In Europe, both forms transferred to varieties of the European species Vitis vinifera, on which they were able to breed only parthenogetically. Transition to the new host was relatively easy, as Prints's experiments showed (1937). In Azerbaydzhan, probably more than forty years after they had began living on the European varieties, both forms lost the ability to form galls on the leaves of all 18 suggested American varieties and retained the ability to feed on the roots of 3 or 4 varieties, including rupestris du Lot (Prints, 1935). After a further 10 years, the Phylloxera lost the ability to feed even on the rupestris du Lot. A similar picture was observed in the Kuban', in Switzerland, and also in Argentina, where loss of the capacity to feed on the American vines was noticed after the Phylloxera had fed for 15-20 years on the European varieties (Prints, 1958).

[8]This was accompanied by important morphological changes which will be the subject of a separate paper.

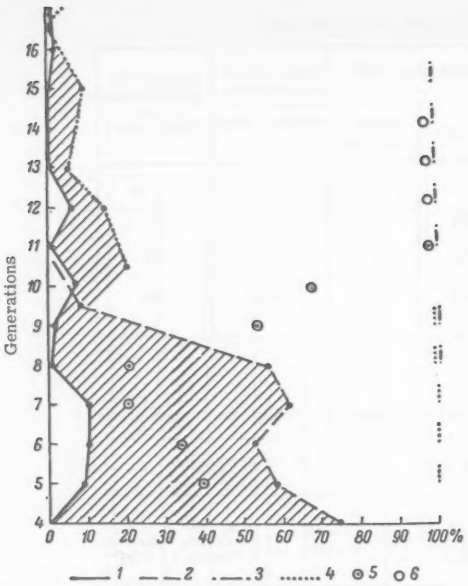

Fig. 1. - Mortality rate for Dysaphis anthrisci majkopica Shap. larvae (clone 0197) reared on various plants. 1 - on Anthriscus (control); 2 - on Chaerophyllum bulbosum 3 - on Ch. maculatum; 4 - on Ch. maculatum; transferred from Ch. bulbosum; 5 - on Anthriscus, transferred from Ch. bulbosum; 6 - on Anthriscus, transferred from Ch. maculatum.

The cases involving grapevine Phylloxera and a. majkopica can be grouped together under the term trophic adaptation. Here, too, however, the distinctions should be emphasized. In a. majkopica, loss of the capacity to live on the former host occurred simultaneously with the adoption of a new host; in the Phylloxera, it occurred much later: the insects were at first in a condition of prolonged trophic adjustment.

While drawing attention to the differences between trophic preferences, adjustments and adaptations, we must stress that there are manifold transitions from one to another of these conditions.

How do they relate to specialization? Following Bykhovskiy (1957) I understand specialization as potentiality on the part of the parasite to live on a definite group of hosts. From this starting point, however, it is extremely difficult to decide what happens to the parasite's specialization when it adopts a new, previously uninfested host; is this a manifestation of the specialization potential or does the specialization itself alter?

Irreversibility might serve as a criterion for altered specialization; yet irreversibility under some conditions always leaves the possibility of reversibility under some other conditions. On the other hand, in strict logic, everything that arises in the process of natural selection is irreversible.

In practice, therefore, the acquisition of a capacity to live on a new, previously unused host is more properly regarded only as a manifestation of the potentialities of an existing specialization, no matter whether it has been produced in the course of natural selection or not; whereas loss of the ability to live on a former host, in itself an indication of much deeper internal transformations, should be regarded as a change in specialization.

From this it follows that what we see in trophic preferences and adjustments is the manifestation of the latent possibilities in an old specialization, whereas in trophic adaptations we have an alteration, a replacement of the old by a new specialization.

Studying the host adaptation processes of a. majkopica (Section 4 and Graph 1) we see that the sharp, profound differences in the experimental and the control aphids' relationship to the hosts were not revealed gradually, but all at once. It looks as if the accumulation of a new specialization took place gradually, from generation to generation, but became manifest more or less discontinuously.

As far as we can tell from the facts at our disposal, rapidity of adaptation is directly dependent on the degree of suitability of the food, whereas the rate of natural selection, the depth of adaptation and the specialization change rate, or the rate at which its potentials become manifest, are inversely dependent on the degree of suitability of the food.

Let us take some examples. Ch. bulbosum is more suitable for a. chaerophyllina than for a. majkopica, and adaptation to this plant was more rapid in a. chaerophyllina but less deep; while natural selection was more intensive than in a. majkopica. In the grapevine Phylloxera which had fed on an easily assimilated food (the European grapevine), change in the specialization set in only after at least several tens of generations, whereas in a. majkopica, which had fed on Ch. bulbosum, a plant difficult for it to adopt, altered specialization occurred after only eight generations in all. The degree of suitability of the diet undoubtedly exerts a stronger effect on the rate of adoption of the new host than the degree of polyphagy of the insect. In the monophage a. majkopica, for example, and the polyphage Neomyzus circumflexus Buckt. (Smirnov and Chuvakhina, 1952, 1953), the moment of break in the adoption of a new unsuitable food set in after the insect had fed on the new plant for 7 to 8 generations, whereas in the monophage a. chaerophyllina this occurred after only 3-4 generations.

The depth of adaptation depends on the rate and duration of the natural selection process; that is, it depends largely on the number of individuals eliminated.

To summarize: in the adoption of a new host, adaptations come into existence; these differ in depth, depending on the rate and duration of the natural selection process, and may be so deep that an old specialization is replaced by a new one.

Section 10. The probability of adaptations to new hosts in nature.

In the experiments, adaptations were produced under the following conditions, achieved by way of artificial selection: 1) at the start of the experiments, a potentially polyphagous clone of aphids was put randomly with highly susceptible individuals of a potential host; 2) in the course of a series of generations, the aphids were provided with susceptible individuals of the adoption plant; 3) an isolator was used to prevent the aphids from having any possibility of leaving the new host in search of the old; 4) the formation of adaptations to a previously unsuitable plant was ensured by preliminary alteration of the specialization to an intermediary plant.

What possibility is there in nature for the creation of a similar combination of favorable circumstances in which adaptations can form? Conditions 2) and 3) can be produced when the aphids attack a whole group (micropopulation) of susceptible individuals of a potential host and, in the course of a number of generations, leave one individual of the alien host to seek another, even more susceptible individual.

Lastly, for adaptation to a previously unsuitable plant to occur, it is essential that a susceptible population of an intermediary plant should be present along with the new host.

Condition 1) depends on the probability of the aphids encountering their potential host. This in turn depends primarily on the quantitative ratio and accessibility of the old (customary) and new (potential) hosts, as well as on the number of aphids and their rate of dispersal.

Other plants which the aphids come across in the course of their search flight may prevent the encounter (Shaposhnikov, 1956: 307-308). We must assume that this is one of the main reasons why plants in a forest thicket are

less infested with aphids than those in a clearing, or than plants growing singly (Section 1); exactly the same applies to mixed plantations, which are less infested than those consisting of one species (Bozhko, 1951; Chu and Chang, 1956; Kotschy, 1958).

An insuperable obstacle to the colonization of a new host by any aphid species is created by asynchronous annual cycles; for example, if the aphid hatching times do not coincide with the budding times of the plant, or if the time when the bisexual generation appears does not coincide with the end of the vegetation period (Swirsky, 1954; Shaposhnikov, 1959); or if the migration period of the aphids (Kennedy, 1953) or indeed of other insects (Kozhanchikov, 1958) does not coincide with the period when their potential host is in a condition suitable for invasion.

Similarly, many other environmental elements — ants (which are enemies of aphids) wind, temperature, humidity, soil, and so forth — can in varying degrees affect the possibility of encounter and subsequent colonization of a new host.

The probability of aphid adaptation to new hosts in nature thus depends, not only on the suitability of the plants and the ability of the aphids to adopt them, but also on a random combination of many other conditions of a biocenotic, ecological or phenological character.

Section 11. Significance of adaptations to a new host in the life and evolution of aphids.

In the experiments, as a result of trophic adjustments (a. chaerophyllina) and adaptations (a. majkopica), groups of individuals developed that were adapted to feeding on a particular diet other than that of their recent ancestors, and also different from that of other related groups of individuals in the same population. Colonization of plants known to be uncharacteristic of the species was more than once observed in nature, too (Section 1).

The subsequent fate of these colonies or groups of individuals will depend also on all other environmental factors, not merely on the food factor. If all conditions are more or less favorable, these groups of individuals will be able to exist indefinitely as independent intraspecies groupings of a biotype or race order, distinct from other, food specialization groupings. If conditions are unfavorable, the aphids will either perish or be obliged to adapt to new hosts, changing not only their food specialization but also other characteristics.

If we take the direction and depth of adaptation as the basis, all the many varieties of intraspecific aphid groupings can be reduced to the following:

Biotypes: trophic adjustments persistent over a long period; the basis is adaptation in the direction of improvement in the use of a more or less suitable diet; adaptation results from a relatively weak operation of natural selection, is not deep and is not accompanied by a change in specialization;

Physiological (trophic) races: trophic adaptations persisting over a long period, based either on adaptation to an unfavorable diet — this adaptation having bypassed the trophic adjustment stage, as in a. majkopica — or on a trophic adaptation arising from an already existing biotype, as in the grapevine Phylloxera (see Sec. 9); adaptation arises in the process of intensive or prolonged natural selection, and therefore its depth is great, and it is accompanied by a change in specialization;

Biological races: come into existence in the process of adaptation to an altered life-cycle of the host or to a change in some other component of the whole complex of ecological and biocenotic conditions constituting the host's environment;

Geographical races come into existence in the process of adaptation to a new topography, new climatic and, above all, new temperature conditions; aphids respond to latitudinal displacement primarily by modifying the life-cycle; in the north, for example, the life-cycle is shortened.

Biotypes and races may have some morphological distinction, which is sometimes fairly important, as in the case of a. majkopica. In most cases, although not invariably, the extent of the morphological differences must be taken as an index to the depth of adaptation.

Subspecies. Races in "pure species" are not so very common. Adaptations which could be attributed to the formation of a race, usually accumulate, as it were, one upon another, coinciding in a single population and in each representative of it.

As an example, we may cite a. majkopica, which in the Maykop district can adapt to feeding on Ch. bulbosum and can form a physiological race on that plant; but in order to adapt also to the life cycle of the new host, which ends its growth period and dies off in July-August, the aphids must modify their own life cycle, which ends in October, by abruptly readjusting the system of reactions regulating the diapause and so forth — in other words, they must form not merely a physiological but also a new biological race. The spread of the aphids along with their new host to new districts may entail the formation of a new geographical race.

Various adaptations, each of which could have entailed or has already entailed the formation of a race, thus accumulate, with the result that the over-all depth of adaptation increases, thereby increasing also the depth of physiological, biological and morphological differences. A qualitatively new intraspecific form arises: the subspecies.

The treatment of intraspecific groupings suggested here can probably be applied not only to aphids but also to other monophagous parasite phytophages, whether of animal or of plant origin.

The presence of intraspecific groupings enables the species as a whole to use a relatively wide variety of environmental conditions. On the other hand, the narrow food specialization of each of them gives them a chance to make the best possible use of the actual, strictly defined, physical and chemical trophic conditions.

The modern view is that form and species formation in most animal and plant species is an allopatric effect due to the isolation of entire populations. The capacity of aphids and other monophagous parasite-phytophages to form isolated intraspecific groupings within a single population suggests that not only allopatric but also sympatric speciation is possible in their case.

Phylogenetic analysis of individual groups and of the whole suborder of aphids shows that their evolution is connected mainly with change of hosts, the main evolutionary path being connected with the transition from trees and shrubs to grasses (Shaposhnikov, 1951, 1956). This transition is not accidental. Climatic changes in the earth's history caused changes in the cycles of woody plants, which in turn forced the aphids to modify their own life cycles. One of the commonest aphid adaptations to changes in the life cycles of their woody hosts is a change of host (Shaposhnikov, 1956, 1959, 1960); but the change of host is effected, as the data given here indicate, through a random combination of favorable conditions, leading to the formation of new trophic adaptations.

According to Mordvilko's hypothesis (1901, 1935), change of host entails in aphids a prolonged period of polyphagy, as an obligatory stage in the transition to the new host. The fact that a. majkopica, a monophage on one plant species, rapidly and abruptly converted to monophagy on another plant species throws doubt, once again, on this hypothesis.

Taking into account the widespread phenomenon of host exchange, we must attribute great importance to trophic adjustments and, in particular, trophic adaptations, and regard them as a possible initial stage, under certain conditions, in the formation of forms, setting the whole process of species formation in a particular channel.

Section 12. Suggestions for the study of these questions for agricultural purposes.

The study of insect food specialization, particularly of monophages, and of the conditions under which they adopt new hosts, is important for an understanding of the transition of local pests to introduce plants, or of accidentally imported pests to local plants. The subject is also important in work with entomophages.

Experimental study of universally resistant and

universally susceptible plants (Sec. 5), and comparison of their physical-chemical and structural peculiarities, can reveal the non-specific conditions determining plant resistance. Some of these have already been indicated (Shaposhnikov, 1959). It may prove possible to find non-specific conditions also in relation to entire ecological groups of insect phytophages at particular stages of their life cycle — for example, in early spring. The discovery of non-specific conditions of plant susceptibility could be of great value in the breeding of hereditarily resistant varieties.

Similarly, the study of individual plant susceptibility and of the conditions determining it (Sec. 6) opens up the possibility of working out a system of controlled modifications in cropping conditions, so as to create non-hereditary plant resistance.

The study of wild or farm conditions preventing the colonization of aphids on plants known to be suitable to them (Sec. 10) is indicating ways of working out prophylactic systems of an administrative-economic or agrotechnical character. An attempt along these lines has already been made by the present author (Shaposhnikov, 1956: 296-312).

SUMMARY

Observations in nature on four similar dioecious forms of aphids of the subgenus Dysaphis CB have revealed certain regularities in their distribution among different situations and in the conditions and character of their infestation of secondary and primary hosts and selection of food plants. They have been found to be narrowly specialized to their hosts.

Side by side with these observations, experiments with the same subjects have enabled us to study their specialization in greater detail. The specialization has appeared wider in the experiments than in nature.

By combining extremes (the most readily adaptable aphid individuals with the most susceptible plant individuals) we have succeeded in producing aphid adaptations to new plants.

Adaptation to a previously quite unsuitable plant was produced after preliminary alteration of the aphids' specialization by rearing them for 8 generations on an intermediary plant. Once they had adopted the new host the aphids lost the ability to feed on the old host.

The following conclusions can be drawn.

1. Not only species, subspecies, races and biotypes, but also individual clones and even individual aphids display a range of dissimilar specializations to hosts and varying adaptability to new diet. One of the possible reasons for enhanced plasticity in aphids may be the effect of changing conditions of life that have operated over a long time, particularly changes in the trophic conditions. As a result, potentially polyphagous clones form, with relatively broad possibilities of adapting to new food.

2. Plant species, varieties, populations and even clones differ in their susceptibility to aphids. Some are universally susceptible and relatively easily adopted as new hosts by many clones and species of aphids, whereas others, universally resistant, are unsuitable for the majority of clones and species. Individual plants also differ greatly from one another in their susceptibility, which depends largely on the conditions of their growth. The range of potential aphid hosts, that is, of plants which can be adopted by aphids under certain conditions, is much wider than the range of hosts actually infested in nature.

3. A random combination of favorable biocenotic, ecological and phenological conditions may enable potentially polyphagous aphid individuals to encounter at the right time and place highly susceptible potential-host individuals. Given favorable conditions the new host may be adopted by the aphids.

4. In the adoption of a new host without the aid of natural selection, only trophic preferences can arise. Where natural selection operates feebly and briefly, trophic adjustments occur and the aphids, broadly expanding their specialization, become capable of living both on the new and on the old hosts. Lastly, when natural selection operates intensively and for a long time, trophic adaptations arise, and the aphids, acquiring a new specialization, lose the capacity to live on the old host.

Here the depth of adaptation depends on the rate and duration of the natural selection process. The rapidity of the change in specialization, however, seems to depend mainly on the rate of natural selection, which in turn depends on the degree of suitability of the prospective host. With intensive natural selection specialization can change sharply and discontinuously.

5. Trophic adaptations are regarded as a possible (under certain conditions) initial stage in the formation of forms, setting the entire process of species formation in a definite channel. The study of trophic adaptations is promising in terms of practical agricultural needs.

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SOME FEATURES OF CHANGES IN INVERTEBRATE FAUNA WHEN VIRGIN STEPPE IS CULTIVATED

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Man has been affecting nature, using it and adapting it to his own practical ends for hundreds and thousands of years. There is continual replacement of primary landscapes and the biocenoses of which they are composed by secondary (agricultural and urban) landscapes and biocenoses. This process has been subject to growing acceleration and reservations are now the only primary virgin areas to remain in many countries. The primary fauna and flora disappear and if some elements manage to avoid the catastrophes created for them by man they are greatly dislocated, lose their initial cenotic links and become components of the secondary biocenoses.

Our country has always had rich reserves of virgin land, but this is now being brought under cultivation on a vast scale and involved in an intensified economic cycle. This utilization is bringing about fundamental changes in local agricultural and natural conditions and affecting marked economic improvements in the districts involved.

When man plows vast areas of virgin land, he replaces the primary natural biocenoses by sown and planted agricultural crops which are a particular form of secondary or cultivated biocenoses (Bey-Biyenko, 1939), which deserve the name agrobiocenoses (Balogh, 1953; Bey-Biyenko, 1957, et al.).

The plants that are the main component in the organic life of an agrobiocenosis show many basic differences from the plants in the primary cenoses (Bey-Biyenko, 1957). These properties must be mentioned. Firstly, an agrobiocenosis contains a limited number of plants, of which only one species — the crop plant (two or more in mixed crops) — is its cenotic constant and dominant; the few remaining plants are weeds, that should ideally not be present in agrobiocenoses. It is also important to note that the plant life of an agrobiocenosis is only maintained by the continual efforts of man and that regular removal of the biological production as harvest is made good by appropriate farming measures. Finally, man also replaces one agrobiocenosis by another by his use of a given rotation or by changing the planting.

Despite these differences, an agrobiocenosis has the basic property of biocenoses — stability of the plant association — although this is reduced to one or a few species of cultivated plants that replace a whole number of constant and dominant species. This relative stability in the organic composition of an agrobiocenosis is also typical of its fauna (Bey-Biyenko, 1939), and largely determines the most fundamental feature of any cenosis — the presence in it of a typical group of organisms over long periods and in stable areas.

It should be noted that the biocenotic study of sowing and planting has only recently become a special trend in animal ecology, but that biocenotic ideas and methods for the faunal analysis of crops and pastures are attracting more and more attention (Bey-Biyenko, Grigor'yeva and Chetyrkina, 1936; Bey-Biyenko, 1939, 1954; Gilyarov, 1943; Balogh, 1953; Schwenke, 1953; Dlabola, 1956; Tischler, 1959, 1960 and others). Certain difficulties are encountered in detailed faunal studies of agrobiocenoses — especially the great wealth of material obtained in such research and the difficulties involved in scientific classification and identification. Workers have therefore often restricted themselves to the study of separate groups of insects and other animals (Burakova, 1929; Bodrenkov, 1949; Yakhontov, 1955, 1957; Strawinski, 1955 and others). The formation of pest faunas has been especially studied in the USSR (Berezina, 1937; Grigor'yeva, 1937; Gilyarov, 1947; Zverezomb — Zubovskiy, 1947; Gilyarov, 1950; Arnol'di, 1951, 1952; Berezina, 1952; Aleynikova, 1953; Nefedov, 1953; Gilyarov, 1955; Kalandadze, 1956; Savzdarg, 1956; Pravdin, 1957; Antonova, 1959, 1960 and others). There is also considerable interest in ecological and faunistic studies of changes in entomological fauna in the creation of sown areas and cultivated landscapes (Medvedev, 1950a, 1954, 1959). At the same time there are still very few works devoted to the whole or a considerable part of the fauna of agrobiocenoses (Bey-Biyenko, Grigor'yeva and Chetyrkina, 1936; Bey-Biyenko, 1939; Kobakhidze, 1943; Ossiannilsson, 1943; Nefedov, 1950; Medvedev, Bozhko and Shapiro, 1951; Chauvin, 1952; Skukravý and Novak, 1957; Schober, 1959 and Chao Tsien-ming 1959). Most biocenotic studies are not directly connected with agrobiocenoses. Indeed, I noted as long ago as 1939 that published work contains "most detailed descriptions of such biocenoses as the arid tundara at Spitzbergen, the Arctic willow thickets of Greenland or the Canadian prairies but not even a brief biocenotic description of areas under the main agricultural crops. It is quite amazing that even wheat, which provides the staple diet of hundreds of millions of people throughout the world, has not been studied in any country as a specific plant and animal association, as a specific biocenosis" ... (Bey-Biyenko, 1939: 123-124). Little has been done since that time; we know a number of details and have a good knowledge of the pest fauna of individual crops and of the biology of each individual pest, but we know little about how they live together, of the nature of their inter-relations with other organisms, the features that distinguish agrobiocenoses from primary cenoses, specific features in the formation of the fauna of an agrobiocenosis as a whole as distinct from some of its pests.

This paper is devoted to a consideration of some of these questions in relation to the biocenosis of a wheat field. I raised the question of research on a wheat agrobiocenosis and parallel research on the initial virgin steppe more than 25 years ago. The information obtained was extremely interesting and instructive, but was only published in part (Bey-Biyenko, Grigor'yeva and Chetyrkina, 1936; Bey-Biyenko, 1939). The events of the next few years combined with new duties and new scientific problems held up further work on the materials obtained and it seemed impossible to return to the question. However, the unprecedented scale of the recent utilization of virgin and fallow land, now sown to wheat, has turned my thoughts once again to the material that I collected and has made me realize that, not only has it not lost its importance, but that it might be said to have anticipated the theoretical and practical problems in general biology and zoology created by the opening up of the virgin lands. This has given me both the strength and the conviction to draw some conclusions from my past research. A fragmentary and extremely brief summary of these results was recently published (Bey-Biyenko, 1957) and repeated in some respects in the paper that I presented to the XIth International Entomological Congress in Vienna in August 1960. Continued interest in these findings makes it appropriate to publish a more detailed paper, containing certain new thoughts, although the paper only deals with the most important questions and does not go into detail.

I began to make biocenotic studies of a wheat field during my scientific work at the All-Union Institute of Plant

Protection in 1935 in the Orenburg steppe near Orsk, where we set up a station at the village of Saverovka; the plant life has been described by Igoshina (1936). These studies were continued in 1936, and in 1937 the fauna of wheat fields was also studied during an excursion through the Orenburg, Aktyubinsk and Kustanay regions.

The same method was used in parallel biocenotic studies of the virgin feather grass steppe (in which Lessing's feather grass Stipa lessingiana – and sheep's fescue – Festuca sulcata – predominated) as the initial primary biocenosis. We also made an experimental study of the effect of plowing virgin land and sowing it to wheat on alteration in the primary steppe fauna. We were therefore in a position to analyse the biocenotic changes that occur when feather grass virgin steppe is sown to wheat.

The main research method was to count the complete terrestrial invertebrate fauna in sixty areas of one tenth of a square meter each; such counts were made approximately every two weeks for the 3-1/2 month vegetation period, to give a total of 36-42 square meters of counted area in each biocenosis.

Information is here given only for the dominant species (i. e. numerically predominating) and the constant species (found in all six or seven counts or in the majority). The other species have not been mentioned in view of the insignificant part that they play in these biocenoses.

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Table 1

Dominant and constant wheat field species (village of Saverovka, near Orsk, 1936; dominant species denoted by an asterisk)

Name of species	Abundance per square meter	
	Average	Maximum
Thysanoptera		
* 1. *Haplothrips tritici* Kurd.	300.4	1622.7
2. *H. acanthoscelis* Karny.	1.47	6.33
3. *Chirothrips manicatus* Hal.	1.86	4.33
4. *Aelothrips fasciatus* L.	0.44	2.17
Cicadina		
5. *Deltocephalus collinus* Dahlb.	0.47	1.50
6. *D. striatus* L.	0.47	1.50
Aphidoidea		
* 7. *Brachycolus noxius* Mordv.	13.90	78.80
Heteroptera		
8. *Aelia sibirica* Reut.	0.17	0.33
9. *Trigonotylus ruficornis* Geoffr.	0.56	2.33
Coleoptera		
* 10. *Adonia variegata* Gz.	1.08	3.83
11. *Phyllotreta vittula* Redt.	1.03	2.33
12. *Chaetocnema aridula* Gyll.	0.44	1.50
13. *Dyschirius globosus* Hbst.	0.30	0.50
14. *Microlestes minutulus* Gz.	0.44	1.17
Formicoidea		
* 15. *Tetramorium caespitum* L.	2.61	6.67
16. *Lasius alienus* Först.	1.42	6.33
17. *Cataglyphus cursor aenescens* Nyl.	1.69	5.00
18. *Formica rufibarbis* F.	0.64	1.83
Lepidoptera		
* 19. *Hadena sordida* Bkh.	2.25	10.20

COMPARATIVE BIOGENOTIC ANALYSIS OF A WHEAT FIELD AND VIRGIN FEATHER GRASS STEPPE

Two years of study of the terrestrial insect fauna and other invertebrates in wheat fields and on the virgin feather grass steppe in the Orsk region and an excursion to investigate the wheat agrobiocenosis revealed some typical features of these biocenoses and differences between them.

I would here mention three previously discovered distinctive features of a wheat field as a biocenosis (Bey-Biyenko, Gregor'yeva and Chetyrkina, 1936; Bey-Biyenko, 1939): 1) the existence of a typical and extremely stable group of constant and dominant species (20 such insect species, many of which were not pests, were discovered in the fields when the crop was ripening); 2) geographical repetition, i. e., the persistence of this group of 20 species (all of which are invariably found in any wheat

Table 2

Dominant and constant species of virgin feather grass steppe (village of Saverovka, near Orsk, 1936; dominant species denoted by an asterisk)

Name of species	Abundance per square meter	
	Average	Maximum
Mollusca		
1. *Vallonia pulchella* Müll.	1.62	3.33
Isopoda		
2. *Cylisticus orientalis* Bor.	1.24	3.67
Acarina		
3. *Caeculus dubius* Kulcz.	2.23	5.50
Collembola		
* 4. *Sminthurus viridis* L.	7.64	18.83
* 5. *Entomobrya quinquelineata* Börn.	4.52	12.50
Blattoptera		
* 6. *Ectobius duskei* Adel	2.83	6.67
Orthoptera		
* 7. *Euchorthippus pulvinatus* F.-W.	3.45	10.67
Psocoptera		
* 8. *Caecilius gynapterus* Tet.	4.55	11.70
9. *Lachesilla* sp.	1.50	4.50
Thysanoptera		
* 10. *Eolothrips cingulatus* Karny	4.26	18.00
11. *Haplothrips acanthoscelis* Karny	2.05	3.17
12. *H. tritici* Kurd.	1.07	4.50
13. *Cephalothrips monilicornis* Reut.	1.43	3.67
Cicadina		
* 14. *Metropis latifrons* Kbm.	4.57	15.67
15. *Graphocraeus ventralis* Fll.	1.93	9.33
16. *Agallia aciculata* Ilorv.	1.31	4.00
17. *Hysteropterum montanum* Fieb.	0.95	4.67
18. *Henschia acuta* Löw.	1.00	2.83
19. *Deltocephalus stipae* Zachv.	0.71	2.50
20. *Sushkinella stipae* Zachv.	0.60	1.50
21. *Euscelis handlirschi* Mats.	0.57	1.83
Heteroptera		
* 22. *Lasiacantha capucina* Germ.	3.45	10.00
23. *Macrotylus attenuatus* Jak.	2.52	11.00

Table 2 (continuation)

Name of species	Abundance per square meter	
	Average	Maximum
24. *Miris ferrugatus* Fll.	0.81	3.33
25. *Geocoris dispar* Waga	0.79	1.67
26. *Neides clavipes* F.	0.71	1.33
27. *Chorosoma schillingi* Schill.	0.24	0.83
28. *Sciocoris cursistans* F.	0.24	0.67
Coleoptera		
29. *Opatrum sabulosum* L.	0.90	1.67
30. *Eusomus acuminatus* Boh.	0.86	4.00
31. *Gonocephalum pusillum* F.	0.45	2.17
32. *Apion elongatum* Germ.	0.27	0.67
33. *Phyllotreta vittula* Redt.	0.05	0.17
Formicoidea		
* 34. *Leptothorax nassonovi* Ruzs.	16.48	25.70
* 35. *Tetramorium caespitum* L.	15.48	29.00
* 36. *Lasius alienus* Först.	13.40	49.00
* 37. *Myrmica deplanata* Ruzs.	3.21	7.33
38. *Formica rufibarbis* F.	1.36	2.83
39. *Cataglyphus cursor aenescens* Nyl.	0.12	0.67
Lepidoptera		
40. *Anthrocera purpuralis* Brünn.	0.38	1.70
41. *Hadena sordida* Bkh.	0.09	0.33

field in the Orenburg, Aktyubinsk and Kustanay regions and undoubtedly in the adjacent regions of the south-east and Kazakhstan); 3) these 20 species account for approximately 93-98% of the total population of terrestrial insects and other invertebrates in the wheat field, i. e. there are only single specimens of all the remaining species (more than 120).

The typical (dominant and constant) species in the wheat and on the virgin steppe can be seen by comparing Tables 1 and 2.

Of the 19 dominant and constant species found in the wheat, only five were abundant and are unconditionally dominant; wheat thrips (No. 1), barley aphid (No. 7), the ladybug Adonia variegata Gz. (No. 10) that devours No. 7, the ant Tetramorium caespitum L. (No. 15) and the gray grain moth (No. 19) that feeds on wheat grains.

All these 19 species are widely distributed and the majority of them were found on ripening wheat (10 July – 12 August) between Orsk, Aktyubinsk and Kustanay (Bey-Biyenko, 1939). This group of species even has features in common with the species found in North American grain fields (Gilyarov, 1943).

The typical species of the virgin steppe are given in Table 2.

Like the typical wheat field species, the species given for the virgin steppe are widely distributed and many of them are typical of a considerable part of the steppe zone; these include Sminthurus viridis, Ectobius duskei, Euchorthippus pulvinatus, Graphocraerus ventralis, Miris ferrugatus, Chorosoma schillingi, Opatrum sabulosum and Leptothorax nassonovi. Some of the species named, and some of those not given here, are also recovered for example, for the Proval steppe on the Donets Highland (Medvedev, 1950b).

The main feature to emerge from a comparison of the dominant and constant species is the marked differences between these biocenoses. Above all, there are twice as many species in the virgin steppe. Hardly any of the dominant species or of the less plentiful constant species are common to both biocenoses; only the ant Tetramirion caespitum is a dominant species common to both, while the constant species include the wheat thrips, its relative Haplothrips acanthoscelis, Phyllotreta vittula, three species of ants and the gray grain moth (Hadena sordida). All these species are widely distributed and are typical both of the steppe zone and, in some cases, of other zones.

Comparison of a number of indices in both biocenoses reveals some very interesting information (Table 3).

The following general conclusions can be drawn from a comparative biocenotic analysis of the virgin steppe and a wheat field:

a) there are more than twice as many species in the virgin steppe (330 species in the virgin steppe and 142 species in the wheat field);

b) on the other hand, the average abundance (i. e. population density) is almost twice as great in the wheat field as on the virgin land (351 per square meter against 199);

c) the number of typical (dominant and constant) species on the virgin land is twice as great as in the wheat field, but is still only approximately half the population (54%), whereas in the wheat field it greatly exceeds all other species and accounts for 94.2% of the total population;

d) consequently the virgin land has a more varied population of insects and other invertebrates, none of which is numerically preponderant; in sown wheat, on the other hand, there is a marked difference between the typical species (dominant and constant) and the rest of the population and a sharp distinction between dominant and nondominant species. In other words the cenotic structure of the virgin land is better balanced, whereas in sown wheat the greater part of the population consists of

a few dominant species, the remaining species being sparsely represented;

e) therefore, the cenotic basis of an agrobiocenosis in itself creates the conditions for the marked domination of individual species and drastic increase in their abundance. Many of these species become plant pests.

Very characteristic changes in the numbers (abundance) of the typical species can be seen when one compares the wheat field with the virgin steppe (Table 4).

The species shown in Table 4 fall naturally into three groups. The first group consists of virgin land species that disappear completely in sown wheat — the snail Vallonia pulchella and the woodlouse Cylisticus orientalis. The second group consists of species which are much less abundant in the wheat field (between 32.2 and 550 times fewer); these are typical virgin land species that are greatly repressed and reduced in numbers in sown wheat (species Nos. 3-7). Finally, the third group consists of species which spurt forward in sown wheat, increasing their numbers by tens and hundreds of times; they are the cereal leafhopper (Deltocephalus collinus), the wheat thrips (Haplothrips tritici), the flea beetle (Phyllotreta vittula), the grain-stem flea beetle (Chaetocnema aridula), the gray grain moth (Hadena sordida) and the ant Cataglyphus cursor aenescens.

An area of virgin feather grass steppe was plowed in the Autumn of 1935 and sown to spring wheat on 27 April 1936 to study the effect of plowing and utilization of the virgin land on alteration in the fauna and biocenotic structure of the population. The same methods previously used on the virgin land and in wheat on old plowland were used to count the population in this wheat field throughout the growing period.

There were very great similarities between the fauna and population in the wheat field on both the virgin land and the old plowland. This is illustrated by comparative figures for the abundance of the main typical species on virgin land and in both types of wheat field from a count on 5-7 August when the wheat was beginning to reach maturity on the virgin field and had reached this stage on the old plowland (Table 5).

In the main it was found that comparative biocenotic study of the wheat field on old plowland and the field on newly plowed virgin soil confirmed the features already described for comparative analysis of virgin feather grass steppe and wheat on old plowland. The new wheat field had the same typical (dominant and constant) species, suppression of virgin land species and similar features. Certain other features revealed have a bearing on the formation of the fauna and population of a wheat field when virgin land is brought under cultivation. These features can be summarized as follows:

a) the basic typical features in the fauna and population of a wheat field on newly plowed virgin land are formed very rapidly (within 45-60 days of the first shoots) by attraction of the species involved from surrounding biotopes and by their subsequent development

Table 3

Comparative biocenotic indices for virgin feather grass steppe and a wheat field.

Biocenotic indices	Virgin steppe	Wheat field
1. No. of species of terrestrial invertebrates	330	142
Including:		
a. Cicadina	35	12
b. Heteroptera	38	19
c. Coleoptera	93	39
d. Hymenoptera	37	18
2. Average abundance (No. of specimens) per square meter	199.0	351.0
3. No. of dominant and constant species	41	19
4. Their general abundance per square meter		
a. Absolute (No. of specimens)	112.2	331.6
b. Relative (as a % of total population)	54.4	94.2

Table 4

Alteration in the abundance of some dominant and constant species in sown wheat as compared with virgin steppe

Species	Abundance per square meter		1 : 2 (—) or 2 : 1 (+)
	1 - Virgin land	2 - Wheat field	
1. *Vallonia pulchella* Müll.	1.62	0	—
2. *Cylisticus orientalis* Bor.	1.24	0	—
3. *Caeculus dubius* Kulcz.	2.23	0.06	— 37.2
4. *Sminthurus viridis* L.	7.64	0.19	— 40.2
5. *Ectobius duskei* Adel	2.83	0.03	— 94.3
6. *Leptothorax nassonovi* Ruzs.	16.48	0.03	—550.0
7. *Graphocraeus ventralis* Fll.	1.93	0.06	— 32.2
8. *Deltocephalus collinus* Dahlb.	0.02	0.47	+ 23.5
9. *Haplothrips tritici* Kurd.	1.07	300.40	+280.8
10. *Phyllotreta vittula* Redt.	0.05	1.03	+ 20.6
11. *Chaetocnema aridula* Gyll.	0.09	0.44	+ 4.5
12. *Hadena sordida* Bkh.	0.09	2.25	+ 25.0
13. *Cataglyphus cursor aenescens* Nyl.	0.12	1.69	+ 14.1

Table 5

Comparative abundance of typical species in virgin feather grass steppe, and in wheat fields on virgin soil and on old plowed land (count on 5-7 August, 1936)

Species	Abundance per square meter		
	Virgin steppe	Wheat on virgin soil	Wheat on old plowed land
1. *Haplothrips tritici* Kurd.	4.50	493.10	154.00
2. *Brachycolus noxius* Mordv.	—	9.92	8.67
3. *Hadena sordida* Bkh.	0.17	0.67	10.20
4. *Adonia variegata* Gz.	—	1.06	3.83
5. *Phyllotreta vittula* Redt.	0.17	0.53	1.17
6. *Tetramorium caespitum* L.	17.67	3.33	2.33
7. *Lasius alienus* Först.	1.00	1.50	1.33

and multiplication;

b) the formation of the fauna, i. e. the development of the total complement of dominant and constant species is complete by the time that the wheat begins to ripen; by this time there is little to distinguish a wheat field on virgin land from one on old plowland (see Table 5);

c) all dominant and constant species are much more abundant in both types of wheat field than in the initial virgin land biocenoses; this preponderance does not always reach the level typical of old plowland in the first year (see Table 5);

d) the dominant species and almost all the constant species on virgin land disappear completely by the time that the first shoots appear when wheat is sown on virgin land or remain in very reduced numbers for a short time.

Thus, the opening up of virgin land leads to total reconstruction of the fauna, to irreversible extinction of all the dominant species and most of the constant species of virgin land and to an unprecedented increase in the numbers of some species.

Consequently an agrobiocenosis is a fragment of the primary cenosis and also a new and qualitatively different biocenosis, in which conditions are especially favorable for the flourishing of some virgin soil species, among which plant pests bulk large. These few virgin soil species become distinctively super-dominant in sown areas and are trophically associated with the crop, either directly as the main food plant or through a feeding chain. Thus man's activity in creating new extensive biocenoses inescapably creates groups of harmful faunas and facilitates their development over large areas.

CONCLUSIONS

These general theoretical conclusions derive from actual investigation. They are also directly related to the practice of plant protection. One can clearly not accept the widely held view that the protection of plants from pests is some sort of temporary activity which need only be carried out while plant pests remain in agrobiocenoses. The same or different pests will continue to exist as long as there are agrobiocenoses, i. e. sown areas and planted crops. When we alter and improve farming technique and open up new areas of virgin land we make fundamental alterations in the living conditions of species, suppressing some and creating optimum conditions for others. This process is as infinite as life itself.

The scientific and practical problem of plant protection is one of reducing the group of especially dangerous pests to the minimum possible under any farming conditions. This is achieved by discovering and using chemical control methods in conjunction with agricultural technique and in relation to organizational and economic conditions. In recent decades great successes have been achieved in the USSR and in the world at large in the chemical control of pests; it has now become clear that this is both rapid and highly economic: the additional harvest recovers the initial outlay 10 to 40 times or more within 1-3 months. Another major advantage of the chemical method is that it enables one to eradicate the threat of a pest rapidly. All these advantages are offset by an extremely important drawback of chemical methods — namely that they must be used regularly, repeatedly or annually; no sooner is the "chemical pressure" relaxed than we are once again faced with great losses in the harvest.

Another approach is to eliminate a pest or greatly reduce its numbers by effecting a controlled alteration in its living conditions by agricultural and organizational measures. This approach necessitates lengthy research, painstaking selection of agricultural techniques, a high level of agriculture and the conversion of agrobiocenoses and even of the whole agricultural landscape (Shchegolev, 1954, Elton, 1958, Grigor'yeva, 1960), but it yields amazing results — the ecological suppression of a pest and the ending of chemical control. This is clearly an ideal to be obtained in plant protection.

Under the special conditions pertaining in the new territories both of these approaches are progressive and should be jointly applied to the great benefit of the national economy.

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COMPARATIVE ANALYSIS OF THE NOCTUID MOTH FAUNA (LEPIDOPTERA, NOCTUIDAE) IN WHEAT FIELDS AND LONG-FALLOW LANDS OF THE VIRGIN TERRITORY IN THE KUSTANAY PROVINCE

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The material for this work consisted of noctuids collected by S. G. Bobinskiy in the course of expeditionary work undertaken in 1958-1959 for the All-Union Institute of Plant Protection in the Kustanay province, together with my own observations on the flight periods and flight rate of the gray grain noctuid Hadena sordida Bkh.

The moths were captured in traps baited with fermenting yeast. Along with the gray grain noctuid, which was a mass pest on wheat fields in the years concerned, we took into account all other noctuid species captured in the traps.

The insects were collected from fields at the Kustanay agricultural experimental station in the Karabalyk district in the northwest part of the province. The fields are divided by tree belts into areas of 4 sq. km. The main tree species in these belts are American maple, cork elm and yellow acacia. The traps were set in spring wheat fields at two sowing periods, in a third-year wheat-grass field, and in a wheat-grass fallow used as a hayfield. Counts were taken daily from early June to the end of August.

More than 5,000 noctuids were collected. These were identified by M. A. Ryabov, who found 71 species. The 1959 collections were completely identified, but the 1958 collections only partially, owing to the poor state of preservation of the material. A list of the species is given below, with an indication of the total numbers, relative abundance, distribution by situation, and flight period of each. The classification adopted is that of Bergmann (1954). Species known as agricultural pests are indicated with an asterisk. The signs + and - indicate the presence or absence of the species in the 1958 collections. Most of the species represented in the collections are widely distributed, and are known from Western and Eastern Siberia, the Urals, the European part of the USSR and Transcaucasia. Only two species, Agrotis trifurca and Leucania deserticola, are endemic in the W. Siberian and Kazakhstan steppes.

The greatest variety of species in our list is found in the subfamilies Hadeninae and Amphipyrinae (26 and 18 species, respectively); representatives of these subfamilies are associated primarily with Gramineae (wheat-grass, wood reed, common reed-grass, spear-grass) and to a lesser extent with dicotyledons (wormwood).

Species of the genera Leucania, Mythimna and Apamea are typical of the steppe lands, particularly of those in the north (Kozhanchikov 1950). Of these, Mythimna pallens, M. conigera, Apamea lateritia, A. obscura, A. rurea and a number of others are the commonest, and often attack wheat and meadow grasses. Hadena sordida must be included among the typical steppe species; it is particularly widespread in the Kazakhstan and West Siberian steppes. Species of the genus Polia inhabit expanses of forest and forest-steppe land, infesting cultivated land well beyond their natural areas.

Cutworms of the subfamily Agrotinae are represented in the list by 16 species, all associated with Gramineae and dicotyledons, primarily goosefoot, and steppe-residents. The commonest species in the Kazakhstan steppes are those of the genera Agrotis and Euxoa. Of the extensive family Cucullinanae, representatives of which are widespread in the steppes and semideserts, only four species are mentioned in our list, all associated with Compositae.

The subfamilies Jaspideinae, Plusiinae, and Catocalinae are poorly represented. Species of the first two are numerous in the eastern steppes and those of the third in the southern varieties of steppe. Certain species (Scoliopteryx libatrix) develop exclusively in association with woody vegetation; their presence in the collections is obviously due to the presence of forest belts on the farm on which they were taken.

The predominant species in the gray grain noctuid, which is widespread throughout the temperate belt of Europe and Siberia but is characterized by outbreaks of mass breeding only in the eastern parts of its area (North Kazakhstan and Siberia). The Hadena sordida population was still high in 1958 and 1959, owing to the mass breeding of Hadena sordida in these regions in 1957.

In 1958 the gray grain noctuids continued to fly from 21 June to 23 July, mass flight occurring from 28 June to 12 July. In 1959 moths appeared in the fields of the Kustanay agricultural station on 5 June and continued to fly until 10 August, mass flight occurring from 25 June to 20 July.

The peak flight period in the wheat-grass fallow was from 10 to 20 June, when a large concentration of moths was observed on sowings of perennial cereal grasses and winter rye which had reached the heading stage during the first 10 days of June. The presence of the ears, which are known to be essential for oviposition by the moth, attracted them to fields where the cereal grasses had reached the stage of ear formation. In winter wheat sowings where the wheat had reached the tillering stage at this time, the moths were found singly. During this period 133 specimens were captured in the traps in the wheat-grass fallow, 73 in the perennial grasses, 38 in the winter rye and only 9 in the early sown wheat. In the early sown wheat, tillering set in during the first 10 days of July, and in the late sown wheat during the second 10 days; by this time, the number of moths in these fields was increasing. The flight was greatest in the late wheat from 13 to 16 July, and coincided with full tillering, but as the production of eggs by the females had by this time fallen sharply, no great infestation by noctuid eggs was observed in this field. Research by Grigor'yeva (1960), Bobinskiy (1961) and others has shown that the gray grain noctuid infests mainly early wheat.

Along with the gray grain noctuid, individual specimens of a related species, Hadena basilinea, the common grain noctuid, were found in the 1959 collections. This moth attacks wheat mainly in the European part of the USSR, and also along the northern and western boundaries of the gray grain noctuid's area in Siberia. An appreciable increase in the population of this pest in the 1959 collections from the forest steppe districts of the Novosibirsk province was recorded (Grigor'yeva, 1959).

Of other representatives of the subfamily Amphipyrinae, one more, Apemea lateritia, the rye stalk noctuid, must be added to the number of persistent and numerous species. This species, widespread throughout Europe and Siberia, has been recorded from the Priamur'ye, Mongolia and Japan, too; and in recent years has been noted in large numbers in the Kurgan (Voskresenskiy, 1959), Tomsk (Zolotorenko, 1959) and Akmolinsk (Shek, 1960) provinces. According to Shek's data (1960) moths of this species fly at the end of July and the beginning of August; the eggs are laid in groups on the leaf sheaths of wheat. The larvae feed on the juicy part of the stalk, moving gradually upwards; towards the end of August, they leave the stalk for the soil, without harming the ears. In 1959, under our conditions,

Table 1

List of Noctuidae species in 1958 and 1959 collections from Karabalyk district, Kustanay province.

No.	Species	In harvest			Numerical distribution by situations, 1959				Flight period
		1958	1959						
		Presence (+) or absence (-)	Abundance	Predominance (%)	Late-sown wheat	Early sown wheat	Perennial grasses	Fallow	
1	2	3	4	5	6	7	8	9	10
	Agrotinae								
1	*Spaelotis ravida* Schiff. (*obscura* Brahm.)*	—	175	5.15	75	15	38	21	10 VI —30 VII
2	*Graphiphora augur* F.*	—	15	0.1	7	—	2	2	20 VI —20 VII
3	*Amathes baja* Schiff.*	+	4	0.1	2	—	—	2	20 VII —30 VIII
4	*A. c-nigrum* L.*	+	30	0.1	8	1	2	15	15 VI —20 VII
5	*Agrotis ypsilon* Hfn.*	+	21	0.1	14	—	2	4	20 VI —30 VI
6	*A. exlamationis* L.*	+	187	5.45	33	20	33	77	5 VI —20 VII
7	*A. corticea* Schiff.*	+	—	—	—	—	—	—	5 VI —20 VIII
8	*A. segetum* Schiff.*	+	26	0.1	8	1	11	5	10 VI —30 VII
9	*A. trifurca* Ev.*	—	1	0.0	—	—	—	1	12 VIII
10	*Euxoa tritici* L.*	+	14	0.1	1	3	2	11	15 VII —20 VIII
11	*E. eruta* Hb. (f. *tritici* L.)*	—	96	2.8	—	10	5	77	10 VII —25 VIII
12	*E. aquilinea* Schiff.*	—	1	0.01	—	—	—	1	10 VIII
13	*E. islandica rossica* L.*	—	2	0.01	—	—	—	1	4 VIII
14	*E. nigricans* L.*	+	54	1.57	2	—	4	47	15 VII —15 VIII
15	*Eurois occulta* L.	+	13	0.1	4	2	1	5	25 VI —25 VII
16	*Ochropleura mussiva* Hb.	—	1	0.01	—	—	—	1	10 VIII
	Hadeninae								
17	*Hadena (Harmodia) luteago* Schiff.	+	6	0.1	—	—	—	6	8 VI —14 VI
18	*H. reticulata* Vill.*	+	7	0.1	3	—	3	1	20 VII
19	*H. literosa* Vill.	—	1	0.01	—	1	—	—	17 VI
20	*Mamestra (Polia) aliena* Hbn.*	+	1	0.01	—	—	1	—	15 VI
21	*M. (Polia) contigua* Schiff.	—	2	0.01	2	—	—	—	12 VI

Table continued

No.	Species	In harvest			Numerical distribution by situations, 1959				Flight period
		1958	1959						
		Presence (+) or absence (–)	Abundance	Predominance (%)	Late-sown wheat	Early sown wheat	Perennial grasses	Fallow	
1	2	3	4	5	6	7	8	9	10
22	*M. (Polia) oleracea* L.*	+	18	0.1	3	3	2	4	25 VI –30 VI
23	*M. (Polia) thalassina* Hfn.	+	215	6.30	72	33	25	50	10 VI – 5 VIII
24	*M. (Polia) suasa* Schiff. (*dissimilis* Knoch.)*	+	12	0.1	2	1	3	5	30 VI –30 VII
25	*M. (Barathra) brassicae* L.*	+	1	0.01	—	—	1	—	17 VII
26	*Polia (Aplecta) nebulosa* Hfn.*	+	21	0.1	5	2	7	3	10 VI –30 VII
27	*P. (Aplecta) bombycina* Hfn. (*advena* Schiff.)*	+	4	0.1	1	1	—	—	15 VI –10 VII
28	*P. (Mamestra) genistae* Bkh. (*w-latinum* Hfn.)	—	13	0.1	—	1	4	4	5 VI – 5 VIII
29	*Discestra (Scotogramma) trifolii* Hfn.*	+	10	0.1	—	—	2	8	5 VI – 5 VII
30	*Leucania (Sideridis) comma* L.	+	6	0.1	3	—	—	3	5 VI –10 VII
31	*L. (Sideridis) deserticola* Bart.	—	3	0.01	—	—	1	—	17 VI
32	*L. (Sideridis) dissimilis* L.	—	11	0.1	5	1	2	2	5 VI –30 VII
33	*Sideridis (Trichoclea) albicolon* Hbn.	+	2	0.01	—	—	—	2	10 VI –15 VII
34	*S. (Trichoclea) egena* Ld.	+	1	0.01	1	—	—	—	15 VII
35	*Mythimna (Sideridis) straminea* Fr.	—	1	0.01	—	—	—	1	15 VII
36	*M. (Sideridis) velutina* Ev.	—	6	0.1	1	3	1	2	5 VII–25 VII
37	*M. (Sideridis) ferrago* F.	+	19	0.1	10	1	1	4	20 VI –25 VII
38	*M. (Sideridis) pallens* la.*	+	9	0.1	4	—	—	5	7 VII–10 VIII
39	*M. (Sideridis) conigera* Schiff.	+	3	0.01	2	—	—	1	15 VII
40	*M. (Sideridis) pudorina* Schiff.	—	3	0.01	—	—	—	3	6 VI –27 VII
41	*Pachetra sagittigera* Hfn.	—	—	—	—	—	—	—	7 VII
42	*Epia irregularis* Hfn.	+							
	Cucullianae								
43	*Calophasia lunula* Hfn.	—	1	0.01	—	—	—	1	17 VI
44	*Cucullia artemisiae* Hfn.*	+	—	—	—	—	—	—	10 VI

Table continued

No.	Species	In harvest			Numerical distribution by situations, 1959				Flight period
		1958	1959						
		Presence (+) or absence (–)	Abundance	Predominance (%)	Late-sown wheat	Early sown wheat	Perennial grasses	Fallow	
1	2	3	4	5	6	7	8	9	10
45	*C. umbratica* L.*	+	—	—	—	—	—	—	10 VI
46	*Parastichtis iners* Germ. (f. *suspecta*)	+	241	7.30	71	26	44	72	5 VI —30 VII
	Amphipyrinae (Zenobiinae)								
47	*Arenostola extrema* Hbn.	—	1	0.01	—	—	1	—	27 VI
48	*A. fluxa* Hbn.	—	1	0.01	1	—	—	—	17 VII
49	*Calamia tridens* Hfn.	—	2	0.01	—	—	—	2	9 VIII
50	*Caradrina albina* Ev.	+	30	0.1	2	1	2	11	10 VI —20 VIII
51	*Hoplodrina ambigua* Schiff.	—	1	0.01	—	2	—	—	9 VII
52	*Caradrina clavipalpis* Scop.	+	10	0.1	3	—	—	6	10 VI —30 VI
53	*C. morpheus* Hfn.	—	4	0.01	2	—	—	2	5 VI —30 VI
54	*Enargia palleacea* Esp.	—	21	0.1	1	2	2	16	15 VII —15 VIII
55	*Hadena basilinea* Bkh. (*Apamea sordens* Hfn.)*	—	6	0.01	—	—	—	6	15 VI —30 VI
56	*Hadena sordida* Bkh. (*Apamea anceps* Schiff.)*	+	1943	56.68	438	294	366	508	1 VI —15 VIII
57	*Apamea (Parastichtis) lateritia* Hfn.*	+	79	2.30	—	3	17	41	30 VI —15 VIII
58	*A. (Parastichtis) oblonga* Haw.	+	23	0.1	7	—	3	11	25 VI —15 VIII
59	*A. (Parastichtis) obscura* Haw.	—	6	0.1	6	—	—	—	15 VII
60	*A. (Parastichtis) pabulatricula* Brahm.	—	1	0.01	1	—	—	—	9 VII
61	*A. (Parastichtis) rurea* F.*	—	1	0.01	—	—	—	1	27 VI
62	*A. (Parastichtis) ferrago* Ev.	—	20	0.1	—	—	—	20	20 VII —10 VIII
63	*Miana (Oligia) literosa* Haw.	—	1	0.01	—	1	—	—	15 VII
64	*Protexarnis confinis* Haw.	—	5	0.01	3	—	—	2	20 VI — 5 VII

Table continued

No.	Species	In harvest			Numerical distribution by situations, 1959				Flight period
		1958	1959						
		Presence (+) or absence (–)	Abundance	Predominance (%)	Late sown wheat	Early sown wheat	Perennial grasses	Fallow	
1	2	3	4	5	6	7	8	9	10
	Heliothidinae (Melicleptriinae)								
65	*Melicleptria scutosa* Schiff.	+	—	—	—	—	—	—	15 VII
66	*Heliothis viriplaca* Hfn.	+	2	0.01	—	—	—	2	17 VII
	Jaspideinae (Erastrianae)								
67	*Tarache luctuosa* Schiff.	—	3	0.01	—	—	—	1	10 VIII
	Plusiinae (Phytometrinae)								
68	*Autographa (Phytometra) confusa* Steph.	—	1	0.01	—	—	—	1	15 VIII
	Catocalinae								
69	*Ectypa (Gonospilea) glyphica* L.	—	1	0.01	—	—	—	1	10 VIII
	Ophyderinae (Noctuinae)								
70	*Scollopteryx libatrix* L.	—	1	0.01	—	—	—	1	12 VI
71	*Calpe capucina* Esp.	—	1	0.01	1	—	—	—	15 VII
					807	430	589	1084	

the moths flew from 30 June to 11 August, and mass flight at all situations took place from 10 to 27 July. The most intensive and prolonged flight was noted in the fallow field, where 40 specimens of moths of this species were collected in one tray. The flight of Apamea lateritia coincides with that of Hadena sordida. Despite the discovery of A. lateritia eggs and larvae on wheat stalks (Shek, 1960), this species, nowadays at any rate, occurs primarily in uncultivated steppe situations. In the collections from the wheat fields it was relatively poorly represented.

Among the species of the subfamily Hadeninae, Mamestra suasa, the sweetclover, garden or distinctive noctuid, predominated in terms of the number of specimens captured. This species, which is widespread throughout Europe, Siberia and the Priamur'ye, has been noted in large numbers in recent years in the Kurgan (Voskresenskiy, 1959), Tomsk (Zolotorenko, 1959) and in the region of the lower and middle course of the Ural river (Kuznetsov and Martynova, 1954). According to published data the larvae of this species feed on herbaceous vegetation – goosefoot, sweetclover, meadow clover, dock and umbellifers. They often attack cabbage, beet, tomatoes, lettuce, cotton, lucerne and clover. Flight was observed from 8 June to 1 August and mass flight from 27 June to 15 July. The occurrence of Memestra suasa on wheat sowings was due to the presence of weeds.

In the subfamily Agrotinae four species clearly predominate: Spaelotis ravida, Agrotis exclamationis, Euxoa tritici, E. eruta (F. tritici). Spaelotis ravida, the yellow-gray noctuid is widespread throughout Europe, Northern and Central Asia, the Priamur'ye, China and Japan. It has been noted in large numbers in the Semipalatinsk province (Filatova, 1931) and in Eastern Siberia (Levchuk, 1935).

Moths of the yellow-gray noctuid fly in fields, parks, gardens and field-protection plantations; the larvae feed on the root parts of herbaceous plants and attack vegetable crops in Kazakhstan, Central Asia and Altay. In 1959, under our conditions, flight occurred from 10 June to 30 July and mass flight from 23 June to 3 July. Moths of this species were recorded in large numbers of wheat.

Agrotis exclamationis, the exclamatory cutworm, is distributed throughout the European part of the USSR, the Crimea, the Caucasus, Central Asia and Siberia, usually in association with the turnip moth A. segetum, which was not very numerous in our collections in either year. In the conditions of Northwest Kazakhstan this species can obviously represent a threat to cultivated and garden crops. The moths were present from 5 June to 20 July in 1959, mass flight occurring from 15 to 20 June and from 10 to 15 July. The largest number of moths was found on the wheat-grass fallow and the smallest number on the early wheat.

The wheat moth Euxoa tritici and its form E. eruta (f. tritici) occupied an important place in the 1959 collections. In geographical distribution, polyphagy and pest importance, this moth is similar to the previous species. The larvae gnaw through the young plants at the root collar. In 1959 the moths of these species occurred from 10 July to 25 August, the most intensive flight being recorded in the wheat-grass fallow from 10 July to 25 August. Mass flight was recorded from 17 to 25 July.

A representative of the subfamily Cucullianae, Parastichtis iners, is the second most numerous species in the 1959 collections. This species is widespread in Europe and Siberia (Seitz, 1906), but has not been recorded in recent years in the faunistic lists for the provinces of the European part of the USSR and Siberia. Koch (1958) remarks that it is associated with damp coastal situations. Both Koch and Seitz connect the development of its larvae mainly with tree and shrub species, and mention transition to herbaceous plants only in relation to the later instars. According to our observations, the moths of this species occurred in nature from 30 June to 28 July, mass flight occurring during a very short period, from 18 to 22 July. Appreciable differences in the invasion of different situations by these moths were not observed. The species has one generation a year.

The remaining 59 noctuid species mentioned in the list were represented by a small number of specimens and made up only 14% of the entire collection.

It can be seen from the list that, under the conditions of the Kustanay province, moths of the genera Spaelotis, Agrotis, Amathes, Mamestra, Polia, Leucania, and Mythimna can be found in fields from early June to mid August. From mid-June to the end of July, moths of the genera Graphiphora, Caradrina and Apamea occur. The shortest and latest flight period is characteristic of representatives of the genus Euxoa.

As regards numbers of species, the list for the unreclaimed part of the cereal-grass fallow is richest; it contains 51 species, and also the largest total number of moths – 1084 specimens. It is characteristic that this part of the fallow had the largest number of species that were relatively abundant numerically.

The opposite trend can be seen in the wheat: only a few individual species are particularly numerous, and the great majority are represented by single specimens; while the noctuid fauna as a whole is poor as regards numbers of species. The list relating to perennial grasses is also somewhat poor in species. The gray grain noctuid unquestionably predominates in the collections from all the plots. If we compare the number of specimens of this moth captured in the wheat and the grass fallow, it can be seen that, although it is an aggressive pest, it continues to be closely associated with uncultivated steppe situations, where the larvae develop on creeping wheat-grass (Grigor'yeva, 1960; Bobinskaya, 1961).

Apart from the gray grain moth, the exclamatory cutworm, numerous in the 1959 and in the 1958 collections, and Euxoa eruta, which became much more numerous in 1959 than in 1958, may be of practical significance in the region under study and in its wheat fields. As regards the group of species associated and their development with wheat and other grain species, are represented in our collections by the species Apamea obscura, A. rurea, A. lateritia, Mythimna pallens, M. conigera and others, it is difficult to predict their future importance for wheat until we know more about their biology, but their persistent presence in the traps in the two years in question indicates that further observation of the variations of their populations in wheat fields is necessary.

All the noctuid species persistently present in the wheat field traps, except the nine species represented by single specimens, were recorded in the collections from the grass fallow. Unreclaimed steppe land is thus one of the sources for the formation of this fauna in wheat fields.

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FORMATION OF THE THE THRIPS (THYSANOPTERA) FAUNA ON WHEAT IN THE NEW AGRICULTURAL LANDS OF NORTHERN KAZAKHSTAN

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Extensive utilization of virgin and fallow land basically affects the life of its inhabitants. The biocenoses created in the feather grass steppe in the course of centuries are destroyed and replaced by new agrobiocenoses (Bey-Biyenko, 1957), the formation of which mass conspicuously featured the research of Bey-Biyenko (1939, 1954, 1957, 1959), Gilyarov (1945, 1955), Grigor'yeva (1937, 1955, 1960) and others. The information thus accumulated can be used in explaining the development on new lands of the biocenosis as a whole and of separate groups of insects, as is here attempted for the Thysanoptera.

Thysanoptera were collected in the Karabalyk district of the Kustanay region on virgin land, cereal grass fallows and sowings of spring wheat on various precursors (virgin land, fallow and old plowland). Simultaneous collections were made on sowings of oats, barley, winter rye, winter wheat and cereal grasses, which here occupy a very small area.

Our studies were made in a district of typical feather-grass motley-grass steppe, with a preponderance of sheep's fescue (Festuca sulcata). There were many species of flowering mixed grasses, but legumes, mints and umbellifers predominated. Despite the great variety of species, the virgin steppe is uniform and largely composed of sod-forming feather grasses and sheep's fescue. Couch (Agropyrum repens) predominated in the cereal grass fallows under consideration. The grass of these fallows has been affected by use (haying and moderate pasturing) so that it is no longer typical but contains many weeds and steppe mixed grasses. The floral canopy, which is sparse and scattered on the virgin land (Kuznetsov, 1933; Igoshina, 1936), is well developed on such fallows.

The main method used to study the species composition of the thrips was sweeping with a net. Counts of plants and areas were used to establish the numbers of certain species with greater accuracy. The thrips on the plants were counted either by carefully examining each plant in the sample or by Evans' method (1933), which is as follows. A large metal grid is inserted in the glass of an oil lamp, and the upper three quarters of the glass is painted black. A plant sample is placed on the grid, the glass is placed in a Petri dish containing water and covered by a lid in which there is a pad moistened with 2-3 drops of turpentine. In their efforts to get away from the source of the smell, the thrips move downward from the plants and fall into the water. Since its lower part is unpainted, the device is also a photo-selector. The device is removed after an hour and the thrips floating in the Petri dish are counted.

When counting thrips in given areas one uses a metal frame enclosing an area of 1/40 square meters with a net attached. When taking a sample, the frame is placed quickly on the ground and all the plants in the area bounded by the frame are in the net. One side of the frame is then lifted slightly and the plants are cut off at ground level with scissors. The mouth of the net is tightly secured and the samples are later examined using Evans's method.

We discovered 37 species of thrips (Table 1) in virgin and fallow habitats and on sown wheat. The greatest number of species was found on the fallow; the thrips fauna was somewhat poorer on the virgin land, and even poorer on sown wheat. There were also considerable variations in the numerical ratios of different thrips species in these habitats.

In order to make a more accurate count of the numbers of thrips we made periodic counts of the insects in small areas in 1960. These counts showed that the total number of thrips in uncultivated steppe is comparatively small (Table 2).

The number of thrips in wheat is more than 20 times that on fallow land, and 40 times that on virgin land. The increase in the number of thrips on sown areas is associated with the great abundance of the wheat thrips (H. tritici), which changes from a rare species in uncultivated habitats to an absolute dominant in wheat fields. A sharp rise in abundance in sown wheat by comparison with virgin land is a regular feature of the majority of harmful insects (Bey-Biyenko, 1939).

Association with a given plant group is one of the factors governing the distribution of thrips by habitat. The great diversity of thrips on fallows is due to the fact that flowering mixed grass is a developed feature of its plant life throughout the season. This favors the development of species that live on flowers and on the leaves of dicotyledons. There are more species of thrips on fallow than on sown wheat and virgin land; and such species as B. icarus, L. denticornis, A. elegans, and species of the genera Thrips and Haplothrips that live on flowers, are relatively abundant. There are few differences in the species represented on virgin land and on fallow, but the numbers are considerably fewer on virgin land. Ch. manicatus is clearly the dominant species throughout the season (63.0-93.0%). These features of the thrips fauna of virgin land are apparently associated with the poorer development of mixed grasses on virgin land, since mixed grasses give rise to more uniform conditions that favor the mass breeding of species adapted to such conditions. B. cingulatus is typical of the virgin steppe fauna.

The major difference between sown wheat and virgin land and fallows in ecological conditions is that the choice of food is practically restricted to a single plant species -- wheat.

This affects the thrips fauna: species whose development is associated with dicotyledonous plants are very poorly represented on sown wheat and can only exist on it because of the presence of weeds. Oligophages, that develop on grasses (we shall henceforward refer to them as grass thrips) find conditions in wheat favorable to their development. There are many more of most species of this group than there are in uncultivated areas. This is particularly noticeable with reference to the wheat thrips.

A. intermedius, the only predatory thrips represented, did not show any marked preference for any of the habitats studied, since it is not very dependent on the nature of the vegetation. It is only recently that this species has been isolated from what was previously a collective species A. fasciatus, which is common in Northern Europe, while A. intermedius is widely distributed in Central and Eastern (Priesner, 1948). I previously identified A. intermedius wrongly as A. fasciatus (Tanskiy, 1958).

When virgin lands and fallows are sown to wheat there is a marked reconstruction of the thrips fauna. Some of the species fail to adapt themselves to the new conditions

Table 1

Species of thrips and their distribution by habitat

Species	Food plant[1]	Wheat field	Fallow	Virgin
Haplothrips tritici Kurd.	Cereal grasses	+++++	+++	+
H. aculeatus Fabr.	»	+++	+++	++
Chirothrips manicatus Hal.	»	+++	++++	++++
Frankliniella tenuicornis Uz.	»	+++	+++	+
Limothrips denticornis Hal.	»	+++	+++	++
L. consimilis Pr.	»	+	+	+
Anaphothrips obscurus Müll.	»	++	+	+
A. omissus Pr.	»	+	—	—
Haplothrips acanthoscelis Karny.	Sod	++	+++	++
Aptinothrips elegans Pr.	Cereal grasses	+	+++	++
Rhipidothrips elegans Pel.	»	+	++	+
Cephalothrips monilicornis Reut.	»	+	++	++
Belothrips acuminatus Hal.	»	—	+	+
Oxythrips brevistylis Tryb.	»	—	—	+
Belothrips icarus Uz.	Sod	—	++++	++
B. cingulatus Karny.	»	—	—	+++
Thrips tabaci Lind.	Dicotyledons	++	+++	+++
T. physapus L.	»	++	++++	+++
T. fuscipennis Hal.	»	—	++	—
T. flavus Schrank.	»	—	+	—
Frankliniella intonsa Tryb.	»	+	+++	+++
F. pallida Uz.	»	—	+	+
Taeniothrips atratus Hal.	»	+	+++	++
T. frici Uz.	»	—	++	++
T. pilosus Uz.	»	—	—	+
Aeolothrips priesneri Knecht.	»	+	+++	++
Odontothrips confusus Pr.	»	+	++	+
O. loti Halid.	»	—	++	—
O. uzeli Bang.	»	—	+	—
Anaphothrips schirabudinensis Jakh.	»	—	+	—
Smyntothrips biuncinatus Uz.	»	—	++	—
Sericothrips staphylinus Hal.	»	—	—	+
Haplothrips reichardti Pr.	»	+	++++	+++
H. angusticornis Pr.	»	—	+++	+++
H. distinguendus Uz.	»	—	+	—
H. leucanthemi Schrank.	»	—	+	+
Aeolothrips intermedius Bang.	Predator	++++	++++	+++

Symbols: +++++ — very many; ++++ — many; +++ — common; ++ — scarce; + — very scarce.

[1] From the literature (Priesner, 1928; Dyadechko, 1954, 1959; Weitmeier, 1956).

and die out, some adapt themselves and continue to exist in the new surroundings, and some find the conditions extremely favorable and increase greatly in number. When wheat is sown on virgin land and on fallows it is rapidly colonized by thrips. We found 20 species of thrips (Table 1) in sown wheat on old plowland. We found 13 species in the first year in wheat sown on fallow and 10 in wheat sown in virgin land. Grass thrips provide the clearest example of the colonization of wheat fields in new land, since the presence of species whose development is not associated with grasses in sown wheat is largely a random occurrence that is dependent on the weediness of the field.

Some idea of the number of thrips species that develop on wheat can be obtained from counts on the plants. Large scale studies revealed that the imago and larvae of five species are found quite frequently on wheat: H. tritici (wheat thrips), H. aculeatus, L. denticornis, F. tenuicornis and Ch. manicatus. All of these are known as cereal pests. We also found single specimens of the imago of an additional five species on ears of wheat: A. obscurus, L. consimilis, T. tabaci, A. elegans and R. elegans. A. obscurus and L. consimilis are known to be cereal grass pests, but the first is not plentiful in Northern Kazakhstan and is found infrequently, while the second is a very narrow oligophage that is exclusively associated with brome-grass (Bromus). The presence of T. tabaci on wheat is accidental, since this species does not develop on grasses. The remaining two species are known to be sod and cereal grass dwellers and are very scarce on wheat. Thus, only the first five species are of importance as potential wheat pests.

These species appear in sown wheat on fallow during the first year (Table 3). The relatively high density of Ch. manicatus and the almost total absence of F. tenuicornis are typical features of wheat sown on virgin land. Both in composition and in numbers, the thrips fauna on plowed fallow is similar to that on old wheat fields. Of all three precursors in the fields (Table 3), wheat thrips is the dominant species.

These features of the thrips fauna are due to the fact that the main formative source of wheat field biocenoses following cultivation of the steppe is the fauna of extensive areas of plowed virgin land, fallows and old plowland (Bey-Biyenko, 1954; Gilyarov, 1955). It has already been mentioned that all the species of grass thrips that are capable of adapting themselves to a wheat diet are found on virgin land and on fallows. The nucleus of the thrips fauna is

Table 2

Dominant species and number of thrips on sown wheat, cereal grass fallow, and virgin land (counts of areas)

Habitat	Number of thrips per square meter			No. of species	Dominant species	
	Imago	Larvae	Total		Species	%
Sown wheat . .	830	4164	4994	9	*H. tritici*	89.0—99.8
Fallow	168	183	351	14	*Ch. manicatus* *B. icarus*	15.6—58.8 8.5—16.8
Virgin land	143	111	254	8	*Ch. manicatus*	63.0—93.0

Table 3

Numbers of cereal grass thrips on sown wheat on old plowland and on new land in the first year of use (average per hundred wheat plants)

Species	Precursor		
	Wheat	Fallow	Virgin land
H. tritici	541.0	415.0	403.5
H. aculeatus . . .	32.5	24.5	18.0
L. denticornis . .	7.0	18.5	13.5
F. tenuicornis . .	5.0	3.5	0.0
Ch. manicatus . .	4.5	4.0	57.8
A. elegans	0.2	0.6	0.0
R. elegans	0.1	0.5	0.0

Table 4

Number of cereal grass thrips and distribution by habitat (counts of areas)

Species	Average Number per square meter		
	Sown wheat	Virgin land	Fallow
H. tritici	762.0	0.0	5.5
F. tenuicornis . . .	27.5	0.0	20.0
H. aculeatus	20.0	1.5	4.5
L. denticornis . . .	7.0	8.0	10.5
Ch. manicatus . . .	6.5	113.0	82.0
A. elegans	0.0	1.0	8.0
Total . . .	823.0	123.5	130.5

therefore formed within a year of first cultivation, but the variety and abundance of the species are largely dependent on the vegetation of the area brought under cultivation. One example is provided by the increased density of Ch. manicatus already noted and the absence of F. tenuicornis from sown wheat on virgin land, owing to the abundance of the first species on virgin land and the isolated occurrence of the second (Table 4). The grass thrips fauna in sown wheat on fallow and on old plowland is similar because of the close relationship between wheatgrass and wheat. The high density of wheat thrips in sown wheat on new land within a year of first plowing is due to migration of the species from old wheat fields and from adjacent areas of virgin land and fallow, where it is always present, although in small quantities. It has been established by observation that wheat thrips is highly capable of migration, in the course of which it can cover relatively long distances. Therefore, even if new sowings are isolated by distances of several kilometers, this does not guarantee them from colonization by these pests (Tanskiy, 1960).

Many other species of grass thrips also colonize easily. Thus, for example, I have captured relatively large numbers of female Ch. manicatus and L. denticornis in the air 700 m from the point of release (recalculation to 1 square meter/hr gave a figure of 2 specimens of Ch. manicatus and 4 specimens of L. denticornis). The great activity of predators makes A. intermedius even more liable to dispersion. Under the same conditions 6 specimens of this species were captured and 4 specimens at a distance of 1000 m.

These observations show that migration from old fields may have considerable bearing on the introduction of thrips to wheat on newly cultivated land when new and old fields are close together. Thus, although the number of thrips species in the area brought under cultivation is decisive in forming the thrips fauna of a wheat field, migrations from old plowlands often play an important part. The difference between the fauna of the newly cultivated areas and old plowland is most noticeable in the year after first plowing, after which it gradually levels down and disappears after 3-4 years.

Thus, a thrips fauna associated with cereal grasses forms very rapidly in sown wheat on new land, although only wheat thrips is now developing on a large scale in these areas. Other species of grass thrips do not increase so markedly on wheat (Table 4). The reasons for this lie in the biological features and food specialization of the individual species. The wheat thrips is a comparatively restricted oligophage that is well adapted to feeding on wheat and only develops on a large scale on this crop: appreciably fewer images of the wheat thrips are found on other cereals and its larvae are very rare (Table 5).

The life cycle of the wheat thrips is well geared to the development of wheat; additional feeding occurs only on winter crops and wild cereal grasses at the beginning of the flight period, since spring wheat is in the tillering stage at this time and presents little attraction to thrips. Mass flight always coincides with the commencement of earing in spring wheat, which now becomes suitable for additional feeding and egg laying. The thrips now colonize the wheat and remain there for the whole of their subsequent development (Tanskiy, 1958). Apart from adaptability to develop on wheat, reduction in the constraining effect of

Table 5

Number of cereal grass thrips on cultivated cereals (average per 100 sweeps of the net)

Species	Crop							
	Spring wheat	Winter wheat	Winter rye	Barley	Oats	Sown wheat-grass	Rootless wheat-grass	Awnless brome
H. tritici	1423	429	184	121	65	107	171	61
H. aculeatus	57	42	120	45	96	66	50	25
Ch. manicatus	24	21	28	136	592	40	198	19
L. denticornis	14	31	255	258	18	2	14	8
F. tenuicornis	12	13	24	36	77	1	1	7
R. elegans	1	6	3	0	0	0	2	0
A. elegans	0.5	0	2	0	0	6	3	1
L. consimilis	0.1	0	0	0.1	0	0.5	1	635

Table 6

Number of wheat thrips and its predators on wheat, fallow, and virgin land (average per 100 sweeps of the net)

Habitat	Species						
	H. tritici	Predators					Thrips — predator ratio
		A. intermedius	*Araneina*	*Adonia variegata* Goeze	*Triphlepa nigra* Wolff	Total	
Sown wheat	1572	53	12	15	1.5	81.5	19.5 : 1
Fallow	17	28	9	1.5	2	40.5	0.42 : 1
Virgin land	4	5	10	0.5	0.5	16.0	0.25 : 1

predators makes an important contribution to the rapid multiplication of wheat thrips in sown wheat. A comparison of the numbers of the wheat thrips and its predators shows that the thrips has far fewer natural enemies on sown wheat than on fallows and virgin land (Table 6).

The numbers of this group of predatory forms increases less rapidly in wheat fields than the numbers of wheat thrips. The numbers of wheat thrips increase hundreds of times, while the predators are only 2-5 times more plentiful. It should be pointed out that the predatory forms mentioned do not represent the total number of predators in virgin and fallow biocenoses, and that, in particular, no allowance has been made for the activity of the ants that abound in virgin steppe. Therefore the relative disparity in predators on virgin land and on fallow is actually even higher.

L. consimilis is also a restricted oligophage whose food plant requirements and life cycle fit it for development on brome (Bromus). Very large numbers of L. consimilis are found on this crop, whereas it scarcely occurs on other cereals (Table 5).

Such species as Ch. manicatus, L. denticornis, F. tenuicornis and H. aculeatus are unrestricted oligophages that are known as pests of many cereal crops: rye, barley, oats, perennial grasses (Körting, 1930; Sakharov, 1947; Mashek, 1957). In Northern Kazakhstan Ch. manicatus mainly attacks oats among the cultivated cereals, and affects rhizomeless wheatgrass and barley to a somewhat lesser extent. It is relatively scarce on the remaining cereals. Overwintered females of L. denticornis that fly early mainly infest winter rye and barley. F. tenuicornis is somewhat more plentiful on oats, barley and winter rye (Table 5). H. aculeatus is found on almost all cultivated cereals and does not exhibit any marked preference for any one of them. Its relative scarcity in Northern Kazakhstan (Table 5) is apparently due to the fact that spring wheat is almost the only crop at the present time, and this only provides conditions for the development of the first generation of H. aculeatus, which there does not have a second generation. In other parts of the country a second generation of this species develops on maize, rice and other crops (Kurdyumov, 1913; Yakhontov, 1953). Now that the area sown to maize is being considerably increased in Kazakhstan, H. aculeatus may increase sharply and become of practical importance as a pest of this crop.

Other thrips associated with cereal grasses include R. elegans and A. elegans, but they are rarely found in wheat fields, since part of their development takes place in sod that is absent in these fields. In addition, A. elegans is wingless and spreads very slowly.

Thus, our study of the thrips fauna has shown that wheat thrips present the greatest danger to wheat fields and that the other species are not at present a great threat to this crop, although they do damage to other cereals (rye, barley, oats and grasses). In view of the relatively small area devoted to these latter crops, they may contain a very high concentration of thrips from virgin land and fallows.

CONCLUSIONS

1. Of the 37 species of thrips recorded in wheat fields, cereal grass fallows and virgin land in the Kustanay region, 10 are associated with cereal grasses and 26 with dicotyledonous plants. One of the species is predacious.

2. All the species of thrips found on wheat and other cultivated cereals are also found in the fauna of the fallows and virgin land. When the steppe is plowed a thrips fauna is formed very rapidly in wheat fields and formation is complete for the most plentiful species within the first

year of utilization.

3. The sowing of wheat on virgin land leads to specialization of the thrips fauna. There is a marked increase in such species as the wheat thrips, while other species associated with old plowland sown to winter rye, barley and oats (L. denticornis, Ch. manicatus and F. tenuicornis) or cereal grasses (L. consimilis) are only slightly more plentiful in wheat fields than on virgin land and fallow, and may even be slightly less plentiful, (e.g. Ch. manicatus).

4. The increase in the wheat thrips in wheat fields is due partly to improved feeding conditions and partly to a reduction in the regulating role and importance of predators. This increase is also assisted by the way in which the life cycle of the thrips fits the phenology of wheat.

5. Only the wheat thrips at present presents a real danger to spring wheat in the virgin land districts. Other species of practical importance are L. denticornis (winter rye and barley), Ch. manicatus, (oats) and L. consimilis and H. aculeatus (brome). Although these species have two generations in the course of the season, the existing cropping plan does not provide conditions for the development of the second generation. As the area sown to maize is increased there may be a mass outbreak that will threaten both maize and wheat.

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FEATURES OF THE INTERRELATIONSHIP OF THE FRIT FLY (OSCINELLA FRIT L.) AND DAMAGED PLANTS WITH REFERENCE TO THE RESISTANCE OF MAIZE TO THIS PEST

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Frit flies (Oscinella Frit L. and O. pusilla Mg.) have become serious and persistent maize pests throughout the non-chernozem zone of European Russia. The stunting caused by this pest leads to great losses in the harvest of green maize, and to a reduction in the value of the crop as fodder. Protection of this important crop from frit flies is therefore of major importance in this zone.

The intimate connection recently revealed between frit-fly damage to maize and white blister damage to the plants (Pavlov and Kozhevnikova, 1957; Megalov and Pang Hsiung-fei, 1959; Shapiro, 1961) indicates that this pest is also of considerable importance in more southerly districts, where its direct damage is normally slight. Frit flies also do serious damage to maize in Western Europe, as is shown by the increasing number of publications devoted to it: Böning, 1952; Kania, 1955; Hahn, 1958; Nolte and Fritzsche, 1959; Masurat and Stephan, 1960, etc.

Chemical control methods are largely used to protect maize shoots against the frit flies at the present time. For a number of reasons these methods do not ensure a sufficient reduction in damage to the plants. This stresses the need for a considerable improvement in protective measures. Our experience shows that one most important way of reducing losses is the use of resistant strains and hybrids. A theoretical basis for solving this problem is provided by an analysis of the interrelations between frit flies and the plants they damage.

STATEMENT OF THE PROBLEM AND RESEARCH METHODS

Research on resistance to pests is greatly complicated by the great number of ways in which this resistance is manifested (Painter, 1953; Chesnokov, 1956).

At the same time, a profound study of the interrelations between pests and damaged plants in relation to dynamic variation in environmental conditions would enable us to establish the most important factors in the resistance of plants to damage and might make it possible to improve this resistance. Therefore, when studying the resistance of cereal grasses to frit flies, the harmful stage of which lives within the plant, particular attention must be paid to analysis of the relationships that develop between the pest and the host plant during the growth and development of both, and allowance must be made for the historically conditioned adaptations of the pest to its specific environmental conditions. Despite the need for this approach to the solution of the problem, we do not know of any studies in which equal attention is paid to even the most important features in the ontogenesis of the pest and the plant at whose expense it lives.

We began research of this type at the Pushkin Research Base of the All-Union Institute of Plant Protection (VIZR) at Pushkin in the Leningrad region. The research involved a combination of field ecology with anatomical histology, biochemistry and morphophysiology. We studied the behavior of the adult insects, the nature of egg laying on the plants and its relationship to the developmental stages and growth processes of the plants; the structure of the larval alimentary canal in relation to the nature of feeding, and some reactions of the plants to damage; the environmental conditions of the larvae within the stems of eared grain (mainly spring wheat) and maize in relation to organogenesis of the plants (differentiation of the vegetative cones, formation and growth of rudimentary leaves within the stem), etc. Considerable use was made of the biological methods for assessing plant development worked out by Kuperman and his colleagues (1955).

I was assisted in my research by N. F. Batygin and Ye. V. Ryzhkova (mainly for the botanical part of the work) and by three research students from the VIZR (L. M. Lisina, S. G. Zhukovskiy and N. A. Vilkova). A. V. Khotyanovich of the staff of the VIZR was concerned with the biochemical side of the research on the enzymatic activity of the excretions of frit-fly salivary glands.

The susceptibility of various varieties, hybrids and inbred lines of maize was studied between 1955 and 1960 in the conditions appertaining in the Leningrad region. The procedure employed was one that we had developed (Shapiro and Batygin, 1957), in which we distinguished five categories of damage by the frit fly. During this period we tested more than 1500 samples of maize from the world collection of the All-Union Crop Research Institute (VIR). The susceptibility of many samples to damage was studied for a number of years. The testing of the varieties was carried out in co-operation with the Department of Maize and Groat Crops of the VIR (headed by F. F. Sidorov).

In this paper we shall deal briefly with those results of our work which, in our opinion have the greatest bearing on an understanding of the principal factors involved in the resistance of maize to the pest.

CONDITIONS FOR LARVAE IN THE STALKS OF THIN-STALKED CEREAL GRASSES AND MAIZE

The biological cycles of species of the genus Oscinella are adapted to life at the expense of the wild and cultivated rhizome grasses and annual loosely bushy grasses that are widely distributed in the forest, forest-steppe and steppe zones (Narchuk, 1955a). Of the many palearctic species only O. frit L. and O. pusilla Mg. damage cultivated cereals. Nefedov (1953) assumes that their transition to feeding on cereals occurred comparatively recently (a few thousand years ago). The cultivation of cereals undoubtedly helped in the development of these species, since it provided the most favorable feeding conditions. It is apparent that frit flies began to adopt maize as a food plant quite recently, since its cultivation began in the Palearctic region.

Since their seasonal cycles do not coincide fully with the growth and development of cereals, these species still retain their feeding links with wild cereal grasses. According to Grigor'yeva and Karpova (1953) this change in food during the season is a biologically positive factor that increases the viability of the O. pusilla population in

the harsh conditions beyond the Volga around Stalingrad.

Without going into detail on the adaptation of frit flies to a change in food plant at different periods during the seasonal cycle, since these are essentially specific to different zones, I should like to stress one extremely fundamental general feature, which is that the larvae and pupae live inside thin-stalked cereal grasses. I have arrived at this conclusion from a comparative analysis of the conditions under which the preimaginal stages of O. frit live and develop in the stems of spring wheat and maize.

It is an important feature of the biology of O. frit and O. pusilla, as well as of other species of this genus, that the larvae feed exclusively within the stalk on the embryonic or only slightly differentiated tissues in the vicinity of the vegetative cone or in ears of grain in the process of formation. The whole organization of these insects is subordinated to the specific features of larval existence within plants.

Since the females lay their eggs early on the plants, the larvae can bore into the stalk when its vegetative cone is still in the very first stages of organogenesis. This is also assisted by the positioning of the eggs on the plants by the females. The frit fly shows a marked tendency to lay its eggs at definite phenological stages – between sprouting and the appearance of the third or fourth leaf.

Larvae of the 1st instar bore into the plants, and from this moment are in active relationship with the host plant. Despite the wealth of literature devoted to various aspects of frit-fly biology, nothing has hitherto been said about the nature of feeding by the larvae. I have concluded (Shapiro, 1958) from microscopic analysis of plant tissues damaged by the larvae, that the digestion of frit fly larvae is extraintestinal. Later research has confirmed this conclusion and enabled us to assess the adaptive importance of this type of feeding to the use made of embryonic or only slightly differentiated plant tissues as a specific habitat by the larvae of certain stem-inhabiting and boring insects (Shapiro, 1959a).

It has been established that the larvae of O. frit use the secretions of the salivary glands for extraintestinal digestion. These secretions contain a specific set of enzymes. It is highly typical that these secretions have both proteolytic and amylolytic activity. This indicates that the larvae feed by active assimilation of plant protein, while carbohydrate nutrition consists of the direct passive assimilation of simple sugars (Shapiro, Khotyanovich and Vedeneyeva, 1960). Both this type of nutrition and the matching set of enzymes are biologically justified and conditioned by the fact that the larvae feed on the embryonic and slightly differentiated tissues of vegetative cones and leaf buds adjacent to the cones. These tissues are known to be very rich in proteins and in monoses. In special experiments conducted in vitro L. M. Lisina established from the effect of the salivary secretions of O. frit on the vegetative cones of Gordeiform – 189 spring wheat in different stages of organogenesis (Kuperman's classification) that the lytic effect of the secretions was highest in slightly differentiated cones.

The important part played by the salivary glands in the digestion of frit fly larvae is also indicated by their very extensive development relative to the other divisions of the alimentary canal (Fig. 1). Examination of the diagram of the larval alimentary canal will show that the larvae can only take previously prepared liquid food. The lumen of their esophagus is so small that it cannot pass individual cells let alone particles of plant tissue consisting of cell aggregates. Mechanical pulverizing of food within the alimentary canal can also be seen to be impossible owing to the absence of any chitinous formations in the anterior sector of the stomach. Nor does examination of the mass in the stomach of a larva reveal any visible formed elements.

Lysis of the vegetative cones and damaged areas of leaf buds surrounding the cones is effected by the secretions of the salivary glands. This slows down or halts the growth of the stem.

It must therefore be recognized that extraintestinal processing of food has reached a high level of perfection in the larvae of the frit fly and that the capacity to produce lytic secretions has an extremely fundamental bearing on the interaction between the insect and the plant. The lytic effect of the secretions of the salivary glands on plant tissue is also of great importance during the penetration of the 1st instar larva into the plant. Narchuk (1955b) states that penetration of the shoot is also assisted by the powerful chaetoid equipment and development system of circumoral canals in this instar. This equipment is noticeably reduced on transition to the 2nd and 3rd instars. The reduction in the number of cuticular processes and the simplification of the system of circumoral canals in the later larval instars is associated with the division of biological functions between different instars. Narchuk states, for example, that the main "biological task" of the 1st larval instar is to enable the pest to reach the feeding site; the intensive feeding of the 2nd and 3rd larval instars leads to the accumulation of reserves. Thus, the development cycle of frit flies usually takes place within a single stalk, in which they usually pupate.

Standardizing selection (Berg, 1956, 1958) has clearly been of decisive significance in the adaptation of frit fly larvae to existence within the stems of cereals. This trend in selection has led to the development of a strict congruence between the shape and size of the insect (larva and pupa) and the internal structure and diameter of the stalks of thin-stalked cereals. It is this circumstance, coupled with the ability of the larvae to produce secretions from the salivary glands, the enzymes in which retard the growth rate and development of vegetative cones, that has made it possible, in essence, for these insects to occupy an extremely advantageous and at the same time ecologically very complicated niche in the region of the vegetative cone of young cereal shoots (Shapiro, 1958, 1959a).

I have obtained the following results from many measurements of O. frit larvae extracted from spring wheat:

	Length, mm	Width, mm
1st instar	0. 72-1. 19	0. 132-0. 264
2nd instar	1. 27-2. 47	0. 264-0. 396
3rd instar	2. 55-4. 37	0. 396-0. 660

The majority of varieties and strains of eared cereals (wheat, rye, barley and oats) have few leaves (4-7) (Kuperman, et al. 1955). Our studies have shown that when the frit-fly larvae penetrate into a spring wheat shoot there

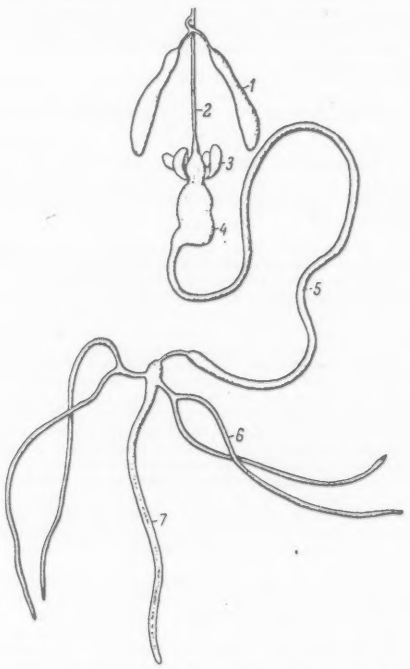

Fig. 1. - Structure of the alimentary canal of the frit-fly larva: 1 - salivary gland; 2 - esophagus; 3 - forestomach; 4 - stomach; 5 - mid intestine; 6 - Malpighian tubes; 7 - hind intestine.

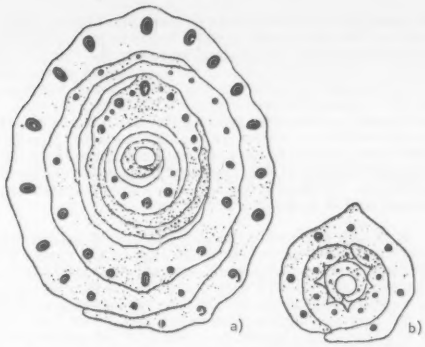

Fig. 2. - Cross sections of maize and wheat shoots in the region of the vegetative cone (diagram). a - Odessa-10 maize; b - Lutescence - 62 wheat.

are only 3-4 leaf layers round the vegetative cone (Fig. 2) and the diameter of the shoot at this time is scarcely 1.5-2 mm. In such plants the vegetative cones are small, fairly broadly based protuberances. Thus, in the first and second stages of organogenesis their base diameter is 0.15-0.20 mm and the height of the cone is 2 mm. The shape and size of the larvae is, therefore, extremely well matched to the internal structure and diameter of the young shoots of thin-stalked cereals. The existence of the powerful larval apparatus for penetrating the plant ensures that the larvae reach the region of the vegetative cone fairly rapidly. It is extremely important that the small size of the larvae enables them to complete the cycle at the expense of the relatively small amount of meristematic tissue in a single stem, which is however of high quality in relation to the provision of energy, since this obviates the need for larvae that are not adapted to an open mode of life to migrate from stem to stem, and is decisive in the preservation of the species. These features enable the insect to halt growth and development in the stems that it damages. The larva completes its development without killing the stem and pupates in it when it is dying. The external indication of this outcome to the interrelationship between the pest and the plant is known by entomologists as the "classic" type of damage to the shoots of eared cereals (oats, barley, wheat and rye) revealed by the withering and dying of the middle leaf (2nd, 3rd, sometimes 4th) followed by drying out of the whole shoot. In this case the cessation in the growth of the stem is associated with destruction of its terminal bud -- the vegetation cone.

This total type of damage to the stems of eared cereals is indicative of the extremely delicate adjustment of the pest to life inside the shoots of these plants. The ontogenetic combination between the insect and the plant is so balanced that the rate of development of the larva outstrips the rate of differentiation of the shoot to a certain extent. Research carried out in my laboratory (Lisina, 1958, 1959) has shown that in addition to the extremely widespread "classic" type of damage there are other types that have not previously been described in the literature (Fig. 3). These types of damage develop when, for any reason, the larva does not damage the vegetative cone ot the shoot to such an extent that its growth is fully halted. This greatly worsens the conditions for completion of larval development in the stalk. As the stalk grows it forces the larva upwards out of the plant system, thus condemning it to death.

The occurrence of different types of damage shows that the adaptations developed by frit flies to existence within the shoots of thin-stalked cereal grasses are relative. The relationships which we have considered are clearly antagonistic. With reference to the conditions that may develop, these interspecific relations can be basically affected and can lead to a completely different outcome for both organisms, i.e. either to death of the plant (stem) or to preservation of the shoot and death of the pest. It should, however, be emphasized that in the majority of cases it is the stems of eared cereals that perish and that the insects complete their life cycle successfully.

Different relationships are formed when the larvae of the frit fly penetrate into the shoots of a thick-stemmed cereal such as maize. This plant has many leaves and there may be from 9 to more than 30, depending on the variety and the cultivation conditions. We have established that when the frit fly larvae penetrate the young maize plants the diameter of the plants is 3-5 mm and 5-6 small leaves have already formed within the shoot. Since some of them are rolled into a tube around the vegetative cone, they form

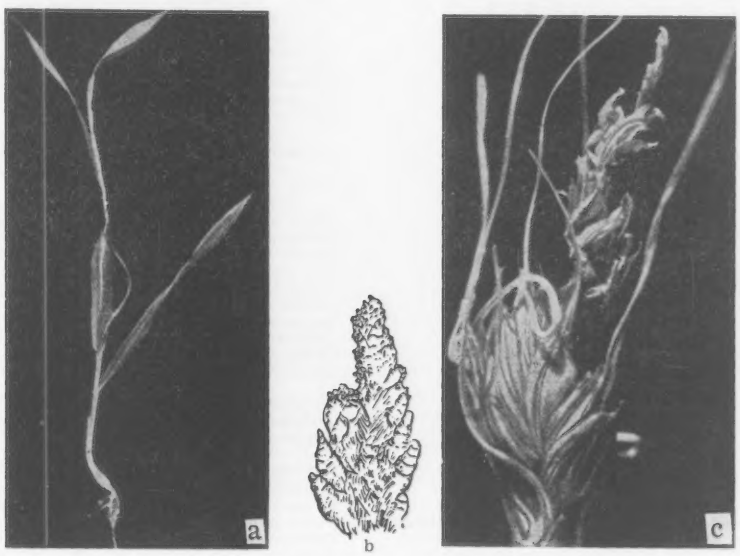

Fig. 3. - Little known types of damage to wheat by frit-fly larvae (L.M. Lisina): a - the vegetative cone of the plant is not destroyed and the damaged stalk continues to grow; b - the vegetative cone is partly damaged in the 5th stage of organogenesis; c - ear from a vegetative cone partly damaged during the 5th stage of organogenesis.

Table 1

Features of the formation and internal structure of the shoots (stems) of Lutescence - 62 spring wheat and Voronezh - 80 maize

		5 days after sowing			11 days after sowing			20 days after sowing		
		Stage in plant development	Short diam.	Long diam.	Stage in plant development	Short diam.	Long diam.	Stage in plant development	Short diam.	Long diam.
Average radius of stem (mm)	Wheat	"Awl" stage	0.59	0.95	2 leaves	0.87	1.25	3—4 leaves	—	—
	Maize	1.5 leaves	1173	1.71	3 leaves	2.06	2.28	4 leaves	—	—
Average number of leaf layers	Wheat	"Awl" stage	3.22	3.33	2 leaves	5.5	6.7	3—4 leaves	6.0	7.0
	Maize	1.5 leaves	8.2	10.9	3 leaves	9.6	12.7	4 leaves	10.3	14.0

1. 5-2 leaf layers (Fig. 2).

My data (Table 1) show that when the frit fly larvae infest the maize shoots the diameter of the stem is 2-3 times that of a wheat stem, and that the larvae have to make their way through at least twice as many leaf layers to reach the vegetative cone. These apparently purely quantitative differences lead to a whole chain of qualitative changes in the conditions under which frit fly larvae live in maize shoots. The many leaf layers are a particularly serious obstacle to the penetration of the larvae to the cone. Observation has revealed that the larvae usually begin to lag perceptibly when starting through the leaf layers of the 3rd and 4th leaves. Continued growth of the leaf layers as the larva passes through them forces the larva upward and it must therefore change direction frequently to reach the cone. Its path therefore follows an intricate broken line and the larva rarely reaches the vegetative cone of the maize. The difficulties encountered by the pest in attempting to reach the embryonic and still slightly differentiated tissues worsen its feeding conditions. All these factors greatly extend the duration of a critical period in the life of the larva.

Although damage to the peripheral leaf layers retards the growth and development of maize leaves and stems it does not bring them to a standstill. As the leaves expand and move gradually upward they carry the larva with them. Our research has revealed that the growth rate of the 3rd and 4th leaves is as much as 3-3. 5 mm/hr or 7-8 cm a day in some maize varieties. Owing to the absence of adaptation for active resistance to the growth force of the leaves, the larvae are carried out of the plant system without, in the majority of cases, reaching the vegetative cone.

This "self cleaning" of larvae by maize begins at the 4th leaf stage and is often completed by the time the 6th-7th leaves unfold. Even in such northern areas as the Leningrad region, almost all the larvae are ejected from the plants along before they finish feeding. It is only when 4-5 and sometimes even 10-11 larvae penetrate one plant, or when the plants are simultaneously damaged by wireworms, flea beetles and other pests that we have very occasionally found the puparia of the frit fly in a maize stem. The bulk of the larvae are carried out of the plant during the 1st and 2nd instars, and very few survive to the beginning and middle of the 3rd instar. The rate at which maize "cleans itself" of larvae, and, therefore, also the age composition of the larvae, are largely associated with the growth conditions of the plants. Therefore the age of the larvae discovered in plants varies both by zones and in relation to weather conditions. On appearing at the surface of the unfolding leaves before they have finished their feeding, the larvae perish under what are, for them, fatal conditions of insolation, rain and wind.

These interrelations of frit-fly larvae and maize that we have singled out for attention are, therefore, an extremely interesting example of a "biological paradox", since female frit flies condemn their progeny to death by laying their eggs on maize. All this shows that frit flies are still in the very initial stage of their adaptation to a new food crop — maize. Despite this, the frit fly does a great deal of damage to maize. This is shown by the material often published in various journals, and put out every year by the services in the Union and Autonomous Republics, that forecast outbreaks of plant pests and diseases and their distribution. I have worked over and published some of this material (Shapiro, 1959b, 1960, 1961).

FACTORS IN THE RESISTANCE OF MAIZE TO DAMAGE BY THE FRIT FLY

Maize (Zea Mays L.) is a polymorphous species. There are typical and quite significant differences in the consistency of the seeds, the height and foliation of the plants, the length of the vegetation period, requirement for heat and other abiotic factors in the many varieties and hybrids. We tested samples of all the known subspecies of maize: pop-corn (Z. M. everta Sturt.), starchy (Z. M. amylacea Sturt.), dent (Z. M. indentata Sturt), flint (Z. M. indurata Sturt.), sweet (Z. M. saccharata Sturt.), pod (Z. M. tunicata Sturt.) and wax corn (Z. M. ceratina Kulesh.).

There were differences of origin, rate of ripening and other factors in the samples belonging to different subspecies.

The damage to the plants was examined when they were in the 7th-8th leaf, i. e. after the damage done by frit-fly larvae was externally quite apparent. We used five categories of damage and calculated a weighed average for the damage to each variety (hybrid).

More than 1500 samples of maize were tested between 1955 and 1960 but none of them was absolutely resistant to the frit fly. Observations of shoots of many varieties of maize revealed that the female frit fly does not show any

Table 2

Comparative damage to different subspecies of maize by the frit fly (Pushkin, Leningrad region, 1958)

Name of subspecies	Name of variety	Number in VIR catalogue	% of damage to plant		Average damage by scale	Frit fly larvae discovered on analysis of shoots			
			Over-all	Plants that died		On average per 100 plants	Break down by instars (%)		
							I	II	III
Popcorn	Black diamond	5949	100.0	43.4	4.05	270.5	3.6	48.9	47.5
Starchy	Kazakh	10085	100.0	16.6	3.25	107.6	7.2	28.5	64.3
Sweet	Golden Bentham	10072	96.0	8.3	3.59	139.0	57.9	38.4	3.7
Flint	1st (Pervenetz) Siberian	—	100.0	4.0	2.44	82.0	46.4	53.6	0
Dent	Sterling	11121	72.2	3.8	1.62	47.2	70.0	30.0	0

Table 3

Comparative damage by frit fly to maize varieties that ripen at different times (Pushkin, Leningrad region, 1958)

Groups of varieties	Number of varieties in group	% of damaged plants		Estimate of average damage by scale	Frit-fly larvae discovered on analysis of shoots			
		Overall	Plants that died		Average per 100 plants	Break down of instars (%)		
						I	II	III
Early ripening	9	96.0	2.5	2.29	70.5	36.3	33.7	30.0
Middle ripening	7	94.8	1.2	1.37	49.1	36.2	57.5	6.3
Late ripening	8	92.2	5.1	1.42	29.0	29.0	64.9	6.1

marked preference for a variety when laying her eggs. It became apparent in the first two years of this work that there were quite fundamental differences in the degree of resistance shown by different groups and varieties (Shapiro and Vilkova, 1959). Dent corn was outstanding for its resistance to frit fly damage; varieties of other subspecies were less resistant. It was also found that late-ripening forms are usually far more resistant to the frit fly than those that ripen early. Later research has confirmed these conclusions. The material obtained (Table 2) shows the great extent of the variation in resistance to the frit fly shown by samples of different subspecies and the number and age groups of the larvae found in the plants. Similar figures (Table 3) are given for varieties of maize with vegetation periods of different lengths.

As an outcome of our work we are able to state which varieties of maize are most resistant to frit fly damage. The best include Voronezh - 80, Bukovina hybrid 2 and 3, Odessa - 10 and others. The use of these varieties reduces the losses due to the frit fly by a factor of 3 or 4 times.

Studies of a number of maize plants that differed greatly in their resistance to frit-fly damage revealed that the main factor in resistance is the accessibility of the vegetative cone of the ear to the larvae, and that the ability of the pest to destroy the cone is the secondary factor. We have already shown that this is connected with the nature of growth and ontogenesis in damaged plants.

The growth rate of the leaves is one important factor in preventing the larvae from reaching the vegetative cone. This largely determines the fate of the insects throughout the period from the laying of the eggs until the plant completes its "self cleaning" of larvae. Thus, the eggs may change their position considerably during incubation,

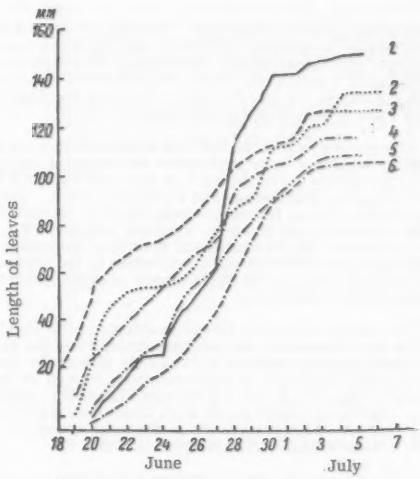

Fig. 4. - Leaf growth dynamics for different varieties of maize: 1 - Voronezh - 80; 2 - VIR - 25; 3 - Moscow early; 4 - Kazan' - 108; 5 - Beloyaroye Psheno; 6 - Strain 29.

Table 4

Structural features of maize shoots in relation to the damage done by the frit fly

Name of variety	Stage in development of plant (number of leaves)	Radius of shoot (mm)		Number of leaf layers		Size of leaves (mm)				Number of frit-fly larvae per 100 plants	Scale estimate of damage (average for 3 years)
						3rd leaf		4th leaf			
		Short diameter	Long diameter	Short diameter	Long diameter	Length	Width	Length	Width		
Voronezh-80	4—4.5	1.92	2.13	10.3	14.0	156.5	13.6	128.7	13.2	39.0	1.09
Odessa-10	4—4.5	1.88	2.16	9.5	12.8	145.5	16.1	119.4	14.8	69.6	1.27
White Rice-716	4—4.5	1.48	1.60	8.4	11.1	131.0	11.9	96.3	10.0	131.5	2.72

Note: The larvae were counted on the 21st day after the shoots appeared.

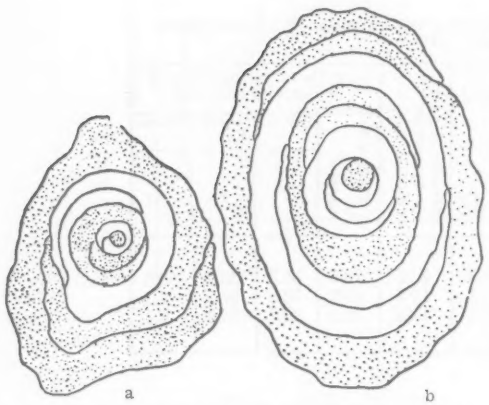

Fig. 5. - Cross sections of maize shoots in the region of the vegetative cone (diagram): a - White rice; b - Odessa - 10.

owing to the growth of the plant. This affects the ability of the larvae to penetrate the shoot, and therefore has a bearing on their availability immediately after eclosion. Conditions are most unfavorable to the pest on varieties in which the leaf plates and the ocrea of the 1st and 2nd leaves put on most growth (Shapiro and Vilkova, 1959).

The growth rate of the 3rd and 6th leaves is even more fundamental, since their successive development and growth forces the larvae out of the zone of embryonic growth in the shoot (Shapiro, Kolomytsev and Ryzhkova, 1959). The growth rate of these leaves has been found to be higher in late- ripening than in early- ripening varieties (Fig. 4). This is because the formation and growth of the leaves take preference over differentiation processes in the vegetative cone of the ear during the early stages of organogenesis in this group of varieties.

The rate at which the larvae penetrate to the vegetative cone is also affected by the internal structure of the shoots. The most important factors here are the size of the shoots and the rate and nature of leaf formation, as well as the number of leaves and leaf layers surrounding the vegetative cone. Carefully graded seeds were used when studying these features of organogenesis in different varieties. Some of the results of this work are given in Table 4.

It can be seen that the formation and growth of leaves is not the same in different varieties. This makes it impossible to assess the internal state of the plant from its appearance. Thus, the number of rudimentary leaves and leaf layers surrounding the growth cone may be different although the same number of leaves have emerged (Fig. 5). The Voronezh - 80 variety, which was one of the most resistant to frit fly has 14 leaf layers which the larva must pass through in order to reach the vegetative cone and there are 10.3 leaf layers along the short diameter. In the White Rice — 716 variety which is greatly damaged by the pest, the larva has to traverse fewer leaf layers in similar movement (11.1 along the long diameter and 8.4 along the short diameter). All the attributes taken into consideration in this research are retarded in the low resistant White Rice-716 variety, i. e. its leaves grow more slowly in length and width, and both diameters of the stalk sections therefore remain smaller.

The number of larvae of the pests discovered in the plants during their analysis indicates the direct link between the damage done and the rate of "self cleaning" by the plants for the varieties considered.

Thus, the materials here given show that the main factors governing the resistance of maize to damage by the frit fly are those that hinder the penetration of its larvae to the vegetative cone. On the occasions when the larva succeeds in reaching the vegetative cone, which are admittedly less frequent in maize than in eared cereals, other factors become operative. These factors are associated with the nature of the vegetative cone itself and with its rate of differentiation and growth. Here early and medium ripening varieties are more favorably situated in relation to resistance to damage by the frit fly since the vegetative cones have already passed through the first stages in organogenesis by the time the larvae penetrate. Owing to the rapid growth of the vegetative cones, the larvae are no longer able to do serious damage to the plant and to kill it or greatly weaken it.

The outcome of the encounter between the pest and the plant should naturally be affected by the activity of the enzymes secreted by the salivary glands and by the nature of the (biochemical and tissue) response of the plants to their effect, as well as by the factors already dealt with. It is therefore to be expected that further research will throw much new light on the nature of resistance.

On the basis of the features already discovered, we are in a position to recommend that such varieties as Voronezh - 80, the Bukovina hybrid 2 and 3, Sterling and Odessa - 10 and others, be used in regions where this peat does continual damage, since they are highly resistant to it. It is also important that the "mechanisms of the resistance" of maize to the frit fly, thus discovered, be utilized by plant breeders to produce more resistant varieties and hybrids.

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THE STUDY OF FIELD CROP ENTOMOCENOSES

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For the last twenty years great attention has been paid to the study of zoocenoses in almost every country in the world. Animal societies are being studied both under natural conditions – those of forest, steppe or desert regions – and under artificial, man-made conditions – in association with field crops, plantations and orchards.

The reason for these studies is that, since in nature no animal species lives in isolation but is associated with its own food plant or with other animal species, the development of each individual species has to be investigated in relation both to the abiotic and to the biotic conditions– trophic interrelationships, parasites and so forth; the whole combination of complex interrelationships in a given biocenosis must be examined in its entirety.

Man, in his battle with insect pests, greatly influences the relationships present in nature. It is therefore necessary to investigate the effect of various control methods, not only on the development of a given pest, but also on the zoocenosis or biocenosis as a whole, and to try and select control methods, and times for applying them, which will do most harm to the pest, and at the same time have the least effect on the zoocenosis as a whole. A planned investigation of the biocenoses of particular crops was carried out in Czechoslovakia in 1952. Teams from the higher institutes of education studied the insect fauna of sugar beets, tobacco maize and clover, and the entomological laboratory of the Czechoslovak Academy of Sciences studied the insect fauna of a potato field and a clover field, and published the results. The same laboratory is at present engaged in studying the insect fauna of the sugar beet.

The purpose of this research was to establish the qualitative and quantitative composition of the insect fauna infesting field crops in Czechoslovakia; to find out how the

Table 1

Finds of weevils (Curculionidae) in clover in 1956 (using an entomological sweep net)

Species	Month and number of specimens collected											
	V			VI		VII		VIII		IX		X
Sitona sulcifrons Thunbg.	23	14	22	178	116	284	126	196	81	121	116	48	213
Sitona hispidulus F.	8		3	4	4				5	8	4	2	16
Sitona humeralis Steph.		1		1						1	3	1	2
Sitona lineatus L.	5	3	1	2				3	3	10	9		2
Sitona crinitus Herbst.				1				1		1	1		
Sitona puncticollis Steph.				1	5	23	1	3					
Phytonomus nigricornis F.			5	10	2	24	4	45	9	36			
Otiorrhynchus ligustici L.					2								
Apion apricans Hbst.	19	9	79	235	136	128	112	105	45	73	26	13	33
Apion varipes Germ.			2	3				6	2	1	1	1	
Apion trifolii L.	3	1	15	27	16	53	21	28	14	22	2		3
Apion seniculus Kirby.	8	7	5	41	18	42	62	100	41	80	93	20	63
Apion virens Hbst.	11		5	2		15		3	2	6	11	6	10
Apion spp.				3		2					2		
Ceutorrhynchus spp.		7		27	5	4		4		2			
Sitona spp. larvae	9	3			250	91	13	10	9	6	3		
Sitona spp. pupae			1		25	83	12	5	2		4		1

populations of different species in this fauna varied during the year; to study the seasonal variations in the dominant species and their trophic associations; and to discover the effect of insecticides on particular insect species infesting the plants concerned.

This paper is a brief review of the results obtained and consists of three parts. In the first part we describe the research procedure. The general characteristics of the potato, clover and sugar – beet insect fauna are described in the second part, and the effect of insecticides on the development of this fauna is described in the third part.

COLLECTION PROCEDURE

In zoocenological studies the quantitative techniques for collecting the insects are of fundamental importance for the provision of data on the population ratios of particular species, and their relative abundance (the number of individuals per unit area). The best way of obtaining quantitative data about the composition of a given insect society is to use a variety of methods. For the routine collections made at intervals of one to two weeks over an entire year we therefore used seven different methods, so as to offset mistakes arising from any particular method and get as accurate a picture as possible of the zoocenosis under study. By way of example we cite the figures relating to aphid findings on potatoes, for which various techniques were used (Fig. 1).

1. The commonest and also the best method of studying the insect fauna in grass cover is to use a sweep net. We used circular nets 30 cm in diameter on a stick 120 cm long and made 50 sweeps in each observation – each sweep covering a length of 1-1/2 meters – repeating the series three to five times. The results have thus been evaluated on the basis of 150 to 250 sweeps.

As this number of sweeps is too small to give adequate data on the less populous species, we sometimes had to make a further 500 sweeps in order to estimate the population of rarer species. The material in the net was frozen with ether or chloroform, and transferred first to a white tin bowl and then to a test-tube containing 70% alcohol. We thus obtained uninjured material even for the small insect species such as thrips, springtails, aphid and leafhopper nymphs and others (see Table, for the numbers of weevils found on clover in 1956).

2. For the soil-surface arthropods, we used ground traps made of food tins 12 cm high and 10 cm in diameter, either empty or with a bait to attract a particular insect species; or else 1-liter glass jars containing 4% formalin as a fixative. These traps were set in the earth and fitted with a tin cap 18 cm square with trimmed edges so as to allow the insects to fall into the trap. The formalin traps were left permanently open under natural conditions from spring to winter and checked at intervals of seven to ten days. Such traps can be used to study ground beetles, grove beetles, earwigs, centipedes and millipedes.

3. The so-called Merick jar, made of glass or tin and measuring 25 cm in diameter and 10 cm in height proved very convenient for studying aphids, parasitic Hymenoptera, many beetle species, and other insects. The jars were colored yellow to attract the insects, and half-filled with 2-3% formalin. The material was collected from them every seven to ten days.

4. Each plant species was checked by carefully examining a predetermined number of plants (roots, stems, leaves and flowers). Ten to twenty plants yielded sufficient information on the commoner species but, for the less common species, 50 to 100 plants had to be checked. A variant of this method is the leaf technique, which gives a good picture of the distribution of species living on the plant leaves – aphids, leaf-hopper nymphs and certain predators, such as ladybugs, syrphid larvae, neuropterous larvae and others. 100 leaves were usually checked on each plant specimen. To ensure uniformity of the samples, the leaves were taken both from the bottom and from the top parts of the plant, and care was taken to see that the collection was made over the entire surface.

5. In the squares method, the surface is marked out into squares of a predetermined size (0.25 or 1 square meter), and in the cylinder method, a particular volume is established. All the Arthropoda on the given surface or in the given volume are then collected. This method yields information on the abundance of the species under investigation.

In the cylinder method we used tin cylinders covering a surface of 0.1 square meters, and having a height of 15 cm; the bottom edge being sharp so that the cylinder could be inserted into the top layers of the soil. A plate-shaped collar 10 cm wide attached to the top edge of the cylinder prevented arthropods outside the soil area covered by the cylinder from falling into it while it was being put into the soil. The grass was cropped and the surface examined all around before the cylinder was placed in the soil. It usually took two workers half an hour to complete the collections of one sample.

6. To study the macrofauna inhabiting the soil (beetle larvae, Diptera, weevils and so forth) we used cylinders enabling us to cut a 500 square meter surface of soil. These cylinders were then checked section by section. The cylinders had sharp teeth on the bottom edge, which easily cut the top layer of soil and the roots. The cylinders can be rotated by means of a wooden rod attached near the top.

7. A special "slamming" device, similar to that used in hydrobiology to collect specimens from the bottom, proved useful in cutting the aboveground parts of plants. The material obtained by this procedure was transferred to a bag and processed exactly as in the net method. It was found that in field crops the number of insects on a 25 square meter surface was very large.

In addition to these methods we used special techniques for studying flies, small glue boards for studying insect movements, and so forth.

GENERAL CHARACTERISTICS OF FIELD CROP INSECT FAUNA

From the qualitative point of view the insect fauna of fields, as of monocultures, is rather poor; but in terms of the number of individuals of particular species which find appropriate conditions for development in them, it is very rich. Usually, 20 to 30% of the species make up 75-85% of the insect population; a further 30-40% of species are represented by at most 10-15% of the individuals and the remaining hundreds of species usually occur only in the form of single specimens. Twenty-eight dominant species were identified in the potato fields, 36 in the clover fields, and 23 in the sugar-beet fields.

The potato is a plant with a very short growth period. It takes only 3-4 months to develop from the time of planting to the time of harvesting. Moreover, repeated cultivation at intervals of 1 to 1-1/2 months has an additional effect on the development of the insects. Clover, as a biennial, presents the better possibilities;

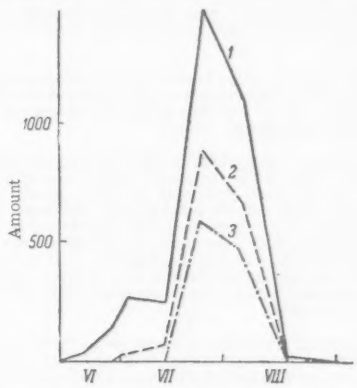

Fig. 1. - Counts of the aphids Medoralis nasturtii (Kalt.) and Myzodes persicae (Sulz.) on potato; collected by three methods in 1954: 1 - net sweeping; 2 - leaf-count method; 3 - squares method.

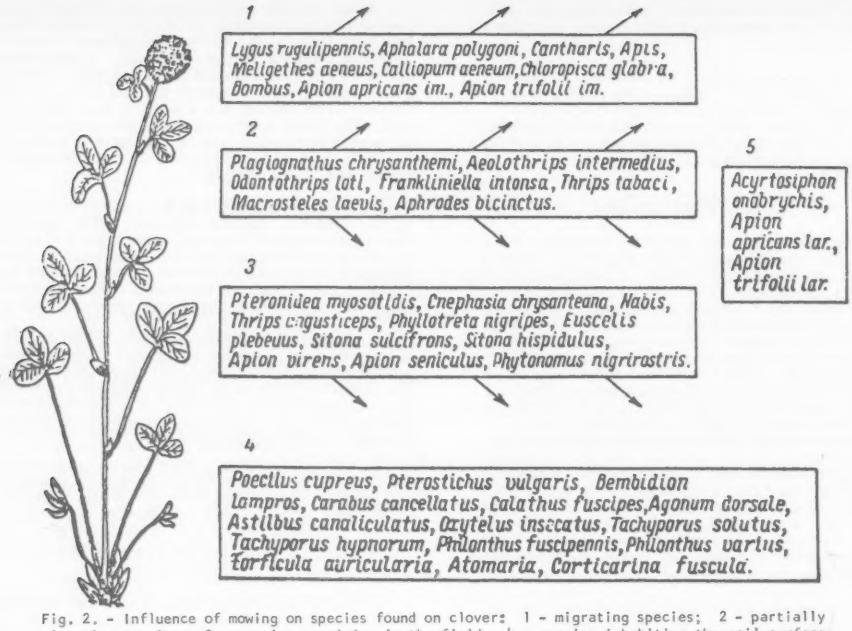
1
Lygus rugulipennis, Aphalara polygoni, Cantharis, Apis, Meligethes aeneus, Calliopum aeneum, Chloropisca glabra, Bombus, Apion apricans im., Apion trifolii im.
2
Plagiognathus chrysanthemi, Aeolothrips intermedius, Odontothrips loti, Frankliniella intonsa, Thrips tabaci, Macrosteles laevis, Aphrodes bicinctus.
5
Acyrtosiphon onobrychis, Apion apricans lar., Apion trifolii lar.
3
Pteronidea myosotidis, Cnephasia chrysanteana, Nabis, Thrips angusticeps, Phyllotreta nigripes, Euscelis plebeuus, Sitona sulcifrons, Sitona hispidulus, Apion virens, Apion seniculus, Phytonomus nigrirostris.
4
Poecilus cupreus, Pterostichus vulgaris, Bembidion lampros, Carabus cancellatus, Calathus fuscipes, Agonum dorsale, Astilbus canaliculatus, Oxytelus insecatus, Tachyporus solutus, Tachyporus hypnorum, Philanthus fuscipennis, Philonthus varius, Forficula auricularia, Atomaria, Corticarina fuscula.

Fig. 2. - Influence of mowing on species found on clover: 1 - migrating species; 2 - partially migrating species; 3 - species remaining in the field; 4 - species inhabiting the soil surface; 5 - species which perished after mowing.

except during the mowing period, the insects can develop on it relatively undisturbed from spring to autumn, and it is therefore much richer in insect fauna than potato.

The development of the potato-field insect fauna falls into three relatively short periods.

1. The spring period (April to the end of May), when plowed earth predominates over green shoots, is characterized primarily by the presence of species inhabiting the soil surface, accompanied by a negligible number of species associated with the potato itself.

2. The summer period (July-August) is characterized by a strong development of species associated with the potato, primarily aphids, flea beetles, leafhoppers and bugs; and by simultaneous development of their predators and parasites.

3. The autumn period (end of August and September) is again characterized by the presence of species associated with the soil surface, and also of species having two generations (Lygus rugulipennis Popp.).

With clover, the periods are less sharply defined, but last much longer. After the winter period, the spring period (late March, April and May) sets in, when, apart from species associated with the soil surface, thrips predominate, and garden flea hoppers occur. This is followed by the summer period (June, July, August), characterized by the presence of aphids, weevils, leafhoppers, and so forth; finally, the autumn period (September, October, November) is characterized by bugs, some cutworms and beetles, inhabiting the soil surface.

Comparison shows that in some cases there is a considerable similarity between different field crops as regards insect fauna, in others substantial differences. Of the order Heteroptera, for example, on clover, potato and sugar beets, Lygus rugulipennis Popp. was always an abundant species, accounting for 68, 69 and 85% of all the Heteroptera found; Chlamydatus pullus Reut. and representatives of the genus Nabis were invariably among the six most numerous species. In two cases, on clover and on potato, Plagiognathus chrysanthemi Wolf was found. In five neighboring fields under different crops (grain, clover, sugar beets), a total of 49 species of ground beetles was found in the course of two years; but of these, 27 were represented only by a small number of specimens, and 9 by only one specimen each. If we compare the different crops in terms of all the species found on them, we observe differences; but if the comparison is only in terms of the most abundant species, the situation is 100% identical on all crops. — For example, the species Pterostichus vulgaris L., P. cupreus L., Bembidion lampros Hbst., Agonum dorsale Pont., Calathus fuscipes Goez., Harpalus rufipes Dej. and affinis Schrnk. were found on all the crops investigated.

Apart from the soil fauna with which we were not specifically concerned, the field insect fauna can be divided into four groups: 1) weed fauna; 2) the fauna of the crop plants themselves; 3) predators and parasites; and 4) cutworms.

The species making up groups 1, 3 and 4 are much the same on all crops. The main differences are found among the insects comprising group 2.

1. The weed fauna is made up of most of the field species, primarily influent species. In properly cultivated fields, conditions favorable to weeds are greatly restricted, and particular insect species infesting weeds will multiply only when the conditions of the crop foster the development of the weeds themselves. Some species of weeds occur with all crops. Such universal weeds include, for example, Agropyron repens, Cirsium arvense, Convolvulus arvensis, Chenopodium album, Galium apparine, Anagalis arvensis.

The insects found on these species are common to all field crops. Examples are the aphis Hayhurstia atriplicis L. on Chenopodium, the leaf hopper Aphalara polygoni (Först.) and the beetle Gastroidea polygoni L. on Polygonum aviculare, species of the genus Meligethes on Raphanus and so forth. Universal clover weeds are Melandrium album, Linaria vulgaris, and Plantago lanceolata; while Galinsoga, Setaria, Euphorbia, Chenopodium and others are universal on row crops.

2. The most fundamental distinction is observed mainly

in species directly associated with cultivated plants. On sugar beets, for example, Aphis fabae Scop. and the fly Pegomyia hyoscyami Panz. form the basis of two very important types of feeding. To a lesser extent, this is true of the beetle Atomaria linearis Steph. and the aphis Myzodes persicae Sulz. On potato, the basis of the main type of feeding is formed by the aphids Doralis rhammi Boyer and Myzodes persicae Sulz.; and on clover, by the aphid Acyrthosiphon onobrychis Boyer and the weevils of the genera Apion and Sitona. Here too, we must include the leaf hoppers Aphrodes bicinctus (Schrank) and Euscelis plebejus (Fallén), thrips of the genus Odontothrips, and also the pollinators.

Mowing plays an important part in the development of the insect fauna, which can be divided into three groups, according to the effect it has on them. The first group includes insects which move rapidly and migrate after mowing to neighboring crops; only a negligible number of them remaining in the mown field. These species again return to clover. The second group covers species for which mowing is an important factor, depriving them of their food and abruptly altering the microclimate. These species only partially adapt to new conditions of life, and for the most part perish after mowing. The third group is made up of species which can live in mown fields, too, or on the soil surface, so that haymaking has little effect on them (Fig. 2).

3. Predators associated with phytophagms species living on weeds and monoculture crops are more or less universal as regards the species represented, the only important differences being that the species are in different numerical ratios on different crops. These predators include the lady beetles Coccinella 7-punctata L., Coccinella 5-punctata L., Propylea 14-punctata L. Adonia variegata Goeze and others, the Syrphids Epistrophe balteata Degeer, Sphaerophoria scripta L., Syrphus corollae L., species of the genera Chrysopa and Nabis, the thrips, Aeolothrips intermedius Bagn., and many species of ground beetles and staphilinids.

4. The cutworm species, although rare in comparison with the other groups, are found on almost all monocultures.

EFFECT OF CHEMICAL TREATMENT ON THE DEVELOPMENT OF THE INSECT FAUNA

Side by side with our study of the composition and development of the insect fauna in particular fields we tried to discover how far chemical interference affected the composition of this fauna and how it renewed itself in cultivated fields. We investigated the effect on potato fields of using DDT in powder and aerosol from against the Colorado beetle and the effect of SYSTOX used against Aphis fabae Scop. on beets. We studied the renewal and further development of the insect fauna in fields treated in this way by comparing them with neighboring control fields. It was found that much depended on the size of the field treated. In small, 1-ha fields, treated with an insecticide of slight residual action (DDT powder), the renewal of the insect fauna was fairly rapid. On experimental potato crops treated with DDT the majority of species were almost completely extermined. The population of quick-flying insects (Hymenoptera, Diptera) was restored to the level of the control field only one week after treatment (Fig. 3); that of Homoptera, Heteroptera and Thysanoptera, after roughly three weeks; and that of crawling Coleoptera, after roughly five weeks. Only a few species of Jassidae (Empoasca pteridis Dahlb., Eupteryx atropunctata [Goeze]) were present in significantly smaller numbers in the treated, as compared with the control, fields after five weeks.

Renewal of the insect fauna was much slower when large areas were treated, and some species never again attained their original numbers throughout the growth period of the crop. Although the quick-flying Hymenoptera and Diptera reappeared in the treated field within ten to fourteen days, and attained roughly the same population as in the control field, the restoration of species belonging to other orders was much slower and depended mainly on the possibilities of migration — that is, on the growth stage at which the species was affected by the insecticide and on the possibilities of migration to neighboring crops. The population of the spring generation of the bug Lygus rugulipennis Popp. in potato fields, for example, was greatly reduced by chemical interference, but the second generation was equally numerous in the control and treated fields. This was partly due to the great migration capacity of the adult form, as well as to the fact that after the wheat harvest these summer bugs revert to their normal habitat in potato fields. The less mobile species inhabiting potato fields mainly in the spring (Aphidae, Cicadidae) increased their numbers very slowly; throughout the growth period the population in the control field was several times higher than in the treated field (Fig. 4). When the insecticide was applied, the ground beetles had already passed their oviposition period, when most of them perish anyway; their numbers were therefore not reduced in the treated fields, and the population of the autumn generation was the same in both the control and the treated fields.

DDT and other contact insecticides have a pronounced effect; most insect species are almost completely exterminated by them, and the population is restored only very slowly. SYSTOX and other systemic insecticides, on the other hand, are more specific, and for the most part affected only those insect species which suck on the plants. We studied this effect in mangel fields. The soil-surface species (Carabidae, Staphylinidae and others) were not affected at all by the insecticide; nor was the composition of the Diptera and Hymenoptera population much disturbed. The effect on Homoptera, on the other hand — particularly on the aphids — was observable throughout the growing period. Similarly, the population of the natural enemies of aphids, mainly the syrphid and lady-beetle larvae, was greatly reduced. Only the population of the adult stage of the lady beetles was the same in the treated as in the control field 14 days after intervention.

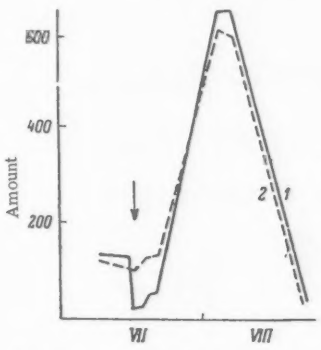

Fig. 3. - Effect 5% DDT powder on findings of Diptera in potato field. 1 - experimental field; 2 - control field. Arrow indicates time when insecticide was applied.

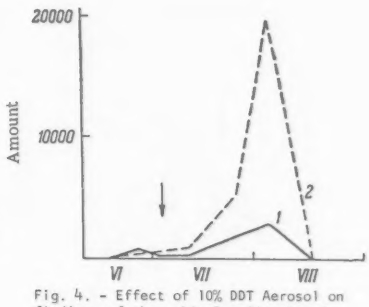

Fig. 4. - Effect of 10% DDT Aerosol on findings of the aphis Doralis rhamni Boyer. d. f. on potato: 1 - experimental field; 2 - control field. Arrow indicates time when insecticide was applied.

Summing up the results obtained we conclude that in the fields we studied there was no further reproduction of the pest species after the insecticide had been applied, because the biological equilibrium was distributed. The use of insecticides does not cause great changes in the qualitative composition of the insect fauna. Resettlement of the cultivated fields is easier because only those species with the ability to migrate – and so to keep alternating between one field and another – usually occur in cultivated fields; they are adapted to the constant changes caused by the cultivation of the soil, the application of fertilizers and the harvesting of the crop. In general, the adverse effect of insecticides on useful species inhabiting field crops can be substantially reduced by choosing an appropriate insecticide and an appropriate time for applying it.

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ON THE BIOLOGY OF THE CURRANT APHIS, CRYPTOMYZUS GALEOPSIDIS KALT. (HOMOPTERA, APHIDIDAE)

L. M. GUSYNINA

Information on the distribution and development of this aphis on plants of the genus Ribes in the Soviet Union is scanty. The data given by Dobrovlyanskiy (1913), who reported on observations on Myzus ribis L., seem to refer to two species at once, the red currant aphis, Cryptomyzus ribis L., and C. galeopsidis Kalt., for the information he gives on the biology of the aphids he observed can be applied partly to one and partly to the other species. Dobrovlyanskiy gives no morphological description. Zirnits (1930) has published data on the development of C. galeopsidis on currant in Latvia.

In 1955-1957 we observed aphids on red and black currant (Ribes rubrum and R. nigrum), in the L'vov province (orchard of the Institute of Agriculture at L'vov and the village of Dublyany.

The fundatrigeniae and their progeny (14 May 1957) feed on the underside of the leaf. On black currant they are often found in small, shallow greenish-yellow swellings of the leaf, which at a distance look like the galls produced on the leaves of the red currant by C. ribis.

The second spring generation consists mainly of winged individuals and a small number of wingless sexuparae. Migration from the currant occurs in the second half of May and the first half of June.

Migrants — wingless sexuparae and larvae — were found on 6 July 1956 and 11 June 1957 on the common nettle (Galeopsis tetrahit L.). A small number of the aphids were scattered on the undersides of the leaves. The infested leaves were not deformed and did not change color. From the end of June until the last days of July 1956 no aphids were found on currant, but further observations showed that a negligible number of them had failed to migrate.

On 29 July and 1 September 1956, wingless parthenogenetic females with two or three larvae were detected on red currant. These were feeding on the under surface of the topmost leaves, where they were found singly. As with the nettle, no changes were observed in the leaves at this time.

These observations correspond to the data of Hille Ris Lambers (1953), who observed that some of the aphids do not migrate from currant, but feed at the beginning and in the middle of summer on the lower leaves, and only towards the end of summer can be found on the upper foliage.

The autumn generations appear on currant in early September. Winged sexuparae with one or two normal female nymphs were noticed on red and black currant from 4 September in 1955 and from 6 September in 1957.

The normal females produced by the winged sexuparae migrating from summer plants reach maturity towards the end of September and the beginning of October. Single individuals of mature normal females, however, were found almost at the same time as the winged sexuparae appeared; that is, on 12 September 1955 on black currant and on 6 September 1957 on red currant. These observations indicate that the time when the normal females appear differs according to whether the individuals are migrating or non-migrating (later, in the latter case). Winged males arrive on currant almost at the same time as the winged sexuparae. The bisexual generation is usually found up to the time the frosts set in.

Individuals of the autumn generations first settle on the lower leaves of the currant, appearing on those of the middle and upper parts of the plants later. The nymphs of ovipositing females produced by winged sexuparae crawl away without forming compact colonies. No eggs were found deposited on shoots which had grown during the current year; the great majority of the eggs apparently winter on older branches.

Wingless sexuparae of the spring and autumn generations differ slightly in morphological characters. Non-migrating wingless sexuparae at the end of summer are only 3/4 the size of individuals of the autumn generation. Towards autumn the length of the antennae and of the hairs on them lengthen relative to the body length and, conversely, the length of the cornicles and of the body hairs decreases.

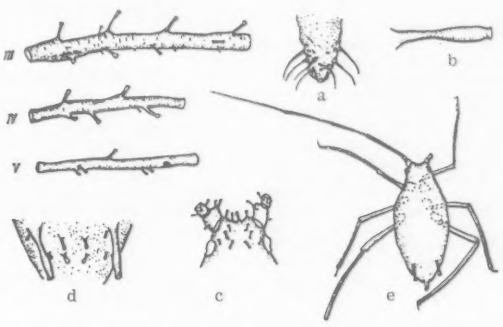

Fig. 1. - Wingless Cryptomyzus galeopsidis Kalt. Sexupara: a - cauda, b - cornicle, c - head, d - 6th-7th abdominal segments, e - general appearance of insect. III - 3rd antennal segment, IV - 4th antennal segment V - 5th antennal segment.

In the wingless autumn individuals, particularly in ovipositing females, the cornicles are much more distended than in the spring sexuparae.

C. galeopsidis differs from the red currant species in the following more noticeable peculiarities of biology and morphology.

Colonies of the red currant aphis cause fairly large, deep, bright-red or yellowish-green swellings to form on the leaves. Under the conditions of the L'vov province the aphids do not all migrate from the currant, single wingless sexuparae remaining to the end of August or into September but feeding in galls formed during the spring.

	Wingless sexuparae	
	C. galeopsidis	C. ribis
1. Number of hairs on 6th abdominal segment	4	6-8
2. Ratio between length of middle hair on 6th abdominal segment and diameter of 3rd antennal segment	3/4-1	3-3-1/3
3. Number of hairs on 3rd antennal segment	12-14	9-12
4. Ratio between length of cornicles and that of body . .	1/6-1/8	1/5-1/6

C. galeopsidis is found from spring onward either in the yellowish-green galls which are only just swelling up or on the underside of unmodified leaves. Migration is again incomplete, but by autumn these aphids are found on the underside of the top leaves, though these retain color and shape.

The preceding are the morphological differences between C. ribis and C. galeopsidis:

Wingless viviparous sexuparae of C. galeopsidis were also observed on 18 July 1958 on black currant at Novosibirsk (orchard of the Institute of Agriculture).

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ECOLOGY OF THE STEM MOTH OCHSENHEIMERIA VACULELLA F.-R. (LEPIDOPTERA TINEOIDEA)

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The earliest information on the destructive activity and biology of this species of stem moth was published by Zhukovskiy and Selivanova (1951), Zhukovskiy and Petrova (1952) and Pavlov (1952, 1954). O. vaculella F.-R. had not previously been known as a pest. Another species of stem moth, O. taurella Schiff., is mentioned in the literature as a rye and winter wheat pest (Keppen, 1883; Kurdyumov, 1913; Znamenskiy, 1926; Shestakov, 1927). According to these authors' findings the stem-moth adults fly in midsummer and lay their eggs on the shoots of winter wheat and on windfalls. The larvae feed inside the terminal bud stems, where the young larvae also overwinter and continue to injure the stems in spring. Pupation occurs inside the ocrea of a top leaf. The growth cycle of O. vaculella differs sharply from that of O. taurella, as we shall see below. The O. vaculella imago has a wing spread of 11-14 mm and a wing length of 6-8 mm. The head is pilose above, the antennae shorter than the wings, but more than half as long as the fore wing. Maxillary palps are lacking. Head and labial palps have long, terminally thickened hairs. Ocelli present. Fore wing dark gray, prolate, with rounded apex and covered with yellow-brown scales, irregular dark brown stripes and diffuse black scales. Hind wing oblong oval, with a white base and brown margins, covered with long hairs. No white maculum on fore wing. Antennae glabrous, not covered with erect scales (this character differentiates the species from O. taurella).

The egg is elongate, oval, 0.6-0.8 mm long and 0.3-0.5 mm wide. The female often lays several eggs at a time, in rows; the eggs then sometimes adhere to one another endwise. The newly laid egg is light yellow but subsequently darkens.

The young larvae are dark yellow with indistinct bands on the dorsum, which usually disappear later; head and occipital area black. Two brown-black plates on anterior segment. In the full-grown larva the body color is lighter. Body without plates, except for the two large ones just mentioned and two on the last segment. The extremity of that segment is covered with a light brown plate of trapezoidal form. Planta of prolegs circular, with two or three hooks. The adult larva attains a length of 18-20 mm and is posteriorly and anteriorly narrowed. Pupation occurs within a dense, white, silken cocoon attached between leaves. The pupa is pale white, accuminate at both extremities and 12-14 mm long.

DAMAGE TO PLANTS BY LARVAE

The larvae started to do great damage to winter wheat in 1949-1952. In 1950-1951 they caused appreciable harm to perennial cereal grasses, but particularly to winter rye. Among the perennial grasses, they damaged the stems of crested wheatgrass (Agropyron cristatum), couch grass (Agropyron tenerum), awnless brome (Bromus inermis) and upright brome (Bromus erectus). The larvae were found also in stems of wild grasses – meadow grass (Poa sp.) and quack grass (Agropyron repens).

They very rarely attack spring wheat stems in normal sowings, but many of them will be found in the stems of spring wheat sown in early winter.

In 1949-1951 these moths were found to have done considerable damage in the Tambov, Orlovsk, Voronezh, Kursk and Penza provinces. At the Tambov land-reclamation station, for example, 4-10% of the rye stems were injured by the moth and in the surrounding collective farms up to 20-30%; at the Chakinskiy selection station up to 35% of the stems were damaged. Considerable damage to rye was noted in 1951 on collective farms in the Talovsk and Buturlinovsk districts of the Voronezh province (up to 25% of the stems).

The larvae cause the formation of white ears on the stalks of winter wheat and perennial cereal grasses, but this is not the principal damage they do. In 1950 and 1951 a different kind of injury predominated everywhere: the stalks of rye, wheat and cereal grasses died as a result of attacks made long before earing. The percentage of stalks killed in this way reached 25.5%, whereas only 2-5% of the stalks suffered white ear damage even on heavily infested plots. A third type of damage is caused when the larvae gnaw through the top part of rye ears while they are still hidden behind the sheathing leaves. Before earing, the larvae often crawl across from one stalk to another, getting in behind the sheathing leaves, and gnaw the top part of the ear, moving upward and thus shortening the ears long before the earing is complete. This almost halves the length of the completed ear, the top part of which is whitened. In 1950 and 1951 there were up to 40% of such ears, with the tips gnawed round; usually the percentage ranges from 5 to 15%.

GROWTH CYCLE OF THE STEM MOTH

The moths lay their eggs in straw heaps in fields, in thatched roofs, cracks in barns and on grain. The larvae formed inside the eggs are left to overwinter and do not emerge from the chorion.

In 1950 and 1951 many thatched roofs over covered threshing floors and other buildings in all the villages in the Talovsk and Buturlinovsk districts were covered by the end of March and the beginning of April with white webbing, within which was found a mass of small stem moth larvae. In some cases there were hundreds of thousands of these larvae per square meter. From 27 March to 5 April the larvae were carried away by the wind, in the webs, hundreds and thousands at a time, or one by one on long threads of the webbing.

In a warm, rapid spring the larvae emerge from the eggs en masse and accumulate in large masses on thatched roofs. Each larva produces one or several silken threads, forming a continuous network. At first the web with its accumulation of larvae forms on southerly roof slopes, but later on northerly ones as well. If calm weather continues for four to six days, the webbing is not carried away by the wind and the larvae stay on the roofs, many of them perishing. On 31 March 1951, for example, 2% of the larvae on roofs well protected from the wind were dead; on 2 April 13%, and on 6 April all, were dead. Cases of the mass death of larvae on roofs, however, are rare; usually the webbing, carrying the larvae with it, is blown away by the strong spring winds, particularly in populated areas unprotected from winds by orchards and forest belts.

On old thatched roofs, the number of webs with larvae will be very high. On new roofs and fresh straw stacks in fields, there are as a rule very few larvae, or none at all. In such cases, they do not form a continuous web, and are dispersed by the wind, one by one, on individual threads.

The larvae are distributed more or less uniformly over fields. This happens because, in places where a web with a large number of larvae is formed, the larvae crawl along the plants, gather on their upper parts, and let themselves down on threads which are then caught up by the wind and deposited, along with the caterpillars, several meters away.

Rye and cereal grasses are infested with the moths up to a distance of 3 km from thatched structures, but the infestation rate in such places is lower than in the vicinity of population centers. At the "First of May" collective farm in the Buturlinovsk district (Voronezh province), 8.0% of the rye stalks were infested at a distance of 200 m from the village, against 0.3% at a distance of 3 km. At the "October Flag" collective farm in the Talovsk district of the same province, 13% of the rye stalks were infested at a distance of 100 m from the village, against 4% at a distance of 1200 m.

When the caterpillars attack the shoots of winter or perennial cereal grasses they first feed on the leaf blades, mining passages in them for 8 to 12 days. In 1951 and 1952 they fed on leaf blades for 6 to 9 days; in 1953, because of the lower temperature (6-12°C), they fed for 10 to 12 days. They then penetrate the stem, that is, inside the central leaf. Zhukovskiy and Petrova (1952) indicate that the caterpillars penetrate the stem on the second or third day, but do this only when the temperature is high (above 20°C). In early spring, when the caterpillars attack the sowings, the mean diurnal temperature usually varies between 8 and 12°C, with the result that penetration into the stems is slowed down and the death rate of the caterpillars rises.

These larvae at first grow very slowly. In 1953, for example, those emerging from the egg were 0.8-1.0 mm long; after feeding for 10 days on the plants in the field, they had grown to only 1.5-2.0 mm. After this, growth is much more rapid: 20 days after feeding, the larvae reach a length of 2.5-3.0 mm; after 30 days, 5.0-6.0 mm; and after 35-40 days, 15.0-20.0 mm. The stems attacked die before emerging into the tube, or soon after. The caterpillars pass from one stem to another, so that, even when there is a comparatively small number of them, a high rate of plant destruction is possible (Table 1).

The figures in Table 1 indicate that stems attacked by the larvae are several times more numerous than the larvae themselves. In early spring, when the larvae are still very small, there is hardly any difference between the number of stems attacked and the number of larvae, for they will not attack more than one stem each at this time. Later, for 4 to 6 days before the earing of rye and cereal grass, mature larvae have already attacked several stems each.

At the end of May and the beginning of June the larvae pupate in cereal-grass leaves, and the moths fly in the first and second 10-day periods of June. The females oviposit only in August and September. At the end of September, a mass of dead moths is found in sheds where grain or straw of cereal crops are kept, and also in granaries. At this time the eggs contain hatched larvae, which winter inside the chorion.

SURVIVAL POWER OF LARVAE ON VARIOUS CROPS AND MORTALITY RATE AT DIFFERENT PERIODS OF LIFE

In 1951 we released 2 to 3 thousand newly emerged larvae over 0.25 square meter sown plots. the plots were covered with isolators consisting of two or three layers of gauze so that the caterpillars could not abandon the plots. Counts of caterpillar density on the plants were then taken periodically (Table 2).

In 1953 caterpillars were released in lots of 100, 300, 600 and 1800 on 0.25 square meter plots sown to winter rye and wheat grass (the plots measured 50 x 50 cm).

There were thus 100, 300, 600 or 1800 caterpillars to 300-400 rye and wheat stalks, (Table 3).

The higher the caterpillar density, the higher their death rate. This was due to unfavorable feeding conditions and to the weather, as well as to predatory ground beetles and ants.

During the first period of life and of feeding on the leaf blades of cereal grasses the death rate was roughly the same as on the rye and wheat grass. The reason why we found fewer dead caterpillars on the wheat grass leaves was probably not that the feeding conditions on that plant were more favorable but that a large number of the dead caterpillars fell to the ground from the narrow leaves of the wheat grass and could not be counted. Later, when the caterpillars penetrate the stalks, their death rate is higher in the wheat grass than in the rye stalks.

At the end of May there were an average of five live full-grown caterpillars, which had started to form cocoons, on 50 rye plants, but only one caterpillar on 50 wheat grass plants. Consequently, out of 2000 caterpillars, about 50 had survived on rye; and only about 10 on wheat grass. Thus, the survival capacity on rye was 2.5, against 0.5% on wheat grass.

On 16 and 17 April 1952 we released 8000 caterpillars over a 1 square meter plot sown to Agropyron tenerum and 8000 over

Table 1

Ratio of stems infested with caterpillars to stems injured by them

Farm	Crop	Date of inspection	% of stems attacked by caterpillars	% of stems with caterpillars	Excess of stems attacked over no. of caterpillars
Institute of Agriculture	Rye	18 V	25.5%	4.9%	5.2
Red Star collective farm	"	12 V	8.0	2.3	3.5
Institute of Agriculture	Winter wheat	10 V	1.5	1.1	1.4
"	" "	16 V	3.4	0.2	6.0
"	" "	24 V	18.4	4.1	4.5
Karl Marx collective farm	" "	13 V	10.2	3.6	3.0
Talovsk State farm	Wheatgrass	18 V	13.2	3.2	4.1
Institute of Agriculture	"	10 IV	0.2	0.2	1.0
"	Agropyron tenerum	14 IV	0.24	0.24	1.0
"	"	12 V	4.7	1.6	3.0
"	"	18 V	4.9	0.4	12.2
"	Awnless brome	18 V	5.0	1.7	3.0
"	Meadow grass	12 V	2.9	0.3	7.7
"	Quack grass	18 V	7.3	1.4	5.2

Table 2

Mortality of stem moth larvae released on to plants in 1951

Date	Number of plants examined	Number of live larvae	Number of dead larvae	Mortality rate, %
Rye				
9 IV	20	117	83	41.5
18 IV	43	84	66	44.0
25 IV	20	34	5	12.8
11 V	30	21	1	4.5
21 V	40	18	6	25.0
30 V	50	5	9	64.3
Agropyron tenerum				
9 IV	21	62	28	31.1
19 IV	50	40	27	40.3
21 V	50	11	7	38.8
31 V	50	1	12	92.3

Table 3

Mortality of larvae on plants in 1953

Original number of larvae	Percentage of dead larvae after release under isolator after			
	10 days	20 days	30 days	40 days
Winter rye				
100	61.0	64.0	70.0	88.0
300	72.0	77.0	80.0	85.0
600	81.0	86.5	88.0	95.5
1800	82.0	85.6	93.8	98.8
Agropyron tenerum				
100	76.0	88.0	88.0	94.0
300	74.0	90.0	92.0	96.0
600	84.0	94.0	95.0	97.0
1800	96.3	98.0	98.6	—

a similar plot sown to the Stepnaya 135 variety of winter wheat. Twenty-six days later only 64 caterpillars were found in 540 winter wheat stalks, which they had penetrated; the rest had perished. The infestation rate of the winter wheat stalks, 29 days after the caterpillars had been released, was only 11.8%, against 14.2% for the Agropyron tenerum; and 3.3%, after 53 days (10 June).

In farm sowings of Stepnaya 135 winter wheat, where infestation by caterpillars occurred naturally, there were 6 live and 24 dead caterpillars on 430 stalks; the infestation rate by live caterpillars was thus 1.4%.

This means that 60-80% of the caterpillars die before they can attack the stalks or, when their density is very high, 80 to 93%. Only a negligible number, about one tenth, succeed in penetrating the stalks. In view of their low survival capacity in the initial stage of life on the plants it is impossible to explain the comparatively severe injury to winter wheat and cereal grasses (5-20% of the stalks) as due exclusively to caterpillars carried from thatched structures by the wind. Moreover, the 1952 and 1953 observations on infestation of thatched roofs by eggs showed that by no means all such roofs contained very large quantities of eggs.

LOCATIONS OF STEM MOTH EGGS

It is of great practical importance to discover where the eggs are laid. If the moths lay their eggs only on thatched roofs and straw stacks, the main, if not the only, control measure would be to destroy the larvae there during the period when they are emerging from the eggs. If the eggs are laid in other places too, additional control methods will be necessary.

In 1952 and 1953 we established the egg population by the following procedure. Layers of straw up to 3-5 cm thick were taken at 10 places so as to give a 1-kg test sample; small portions of the straw and chaff were then sieved and divided into 64 or 128 equal parts, in each of which the eggs were counted with the aid of a magnifying glass. The number of eggs was multiplied by the number

Table 4

Infestation of roofs and of straw and chaff in fields by moth eggs

Year	Location inspected	Description	No. of eggs per kg of straw, chaff and refuse
1952	Shed covered with old thatch	Grain cleaned infrequently	18240
	Threshing floor, roofed 1942	Grain cleaned frequently	549880
	Wheat chaff	1952 harvest	136000
	Roofed threshing floor in steppe	Grain not thoroughly cleaned	138250
	Iron roofed sorting shed	Eggs between planking boards and iron roof	2019200
1953	Roofed threshing floor	Roof thatched in 1952	No eggs
	Roofed threshing floor in steppe	Grain cleaned regularly	70950
	" " "	Grain on threshing floor hardly cleaned at all	490
	Straw and chaff residues in field	5th field	1664
	Roofed threshing floor	Grain cleaned frequently	15360
	Shed, roofed 1948	Grain cleaned infrequently	1152

of portions and the results are shown in Table 4.

In Table 4 the figure for eggs found in the straw of thatched threshing floors where grain is cleaned is strickingly high. These roofs are covered with a thin layer of minute chaff particles, which form attractive oviposition sites for the moth. The more frequently grain-cleaning work is done, the higher the number of eggs found on the roof.

In 1953, infestation by moth eggs was found to be highest in a steppe crop rotation where, more often than in other places, grain had been cleared from under combine harvesters on a roofed mechanized threshing floor. For this reason, the threshing floor roofs in a southern crop rotation were heavily infested in 1952. In places where the grain is cleared rarely, infestation of the roof is negligible. The moths lay large numbers of eggs in the thick layer of dust and webbing accumulated between the planking boards and the iron roof in a sorting shed where unthreshed sheaves are stored every year. Over two million eggs were found in 1 kg of dust and webbing.

It is interesting that the moths do not lay their eggs in similar places (between the planking boards and the iron roof) in other buildings, where grain and unthreshed sheaves are not kept; nor do they lay in fresh thatch or newly-stacked straw.

Roofs infested on collective farms were those which had been thatched a long time ago, and those near places where threshing and grain-cleaning take place.

In 1952-1953 it was established that the moth lays its eggs in heaps of chaff in places where grain is cleaned, and in small scattered heaps of straw and refuse left in the field after combine harvesting. Up to 136 thousand eggs were found per kg of chaff and straw.

A mixture of straw and chaff can consolidate by the beginning of September, that is, by the time the moths lay their eggs; in windy weather this will not be blown away, but will lie compactly, and attract the moth to lay its eggs there. The heat in compost heaps of straw and chaff makes for more intensive egg-laying. The moth avoids laying its eggs in stacks of dry chaff and straw.

In 1952 winter wheat and rye windfall in fields of perennial grasses which had sprouted under the crop cover on the "October Flag" collective farm (Talovsk district) and at the Institute of Agriculture was infested with stem moth larvae to the extent of 8-10%. At the "First of May" collective farm (Buturlinovsk district) the infestation level in the spring of 1951 among windfall shoots of spring wheat on a plot sown to that crop the year before was 5-12%. The level was particularly high in places where the plants had pushed through heaps of scattered straw and chaff.

The interesting point about this heavy infestation of windfall spring wheat shoots is that the infested plots were 3 km from a village -- a place from which the caterpillars could have been brought by the wind. The infestation of the plants was due to the straw and chaff scattered and rotting in the field, rather than to larvae blown from the village roofs, which, incidentally, were only slightly infested.

In 1951 the infestation level of rye on certain collective farms in the Talovsk district and on the Vorob'yevsk state grain farm (Vorob'yevskiy district) was 3.5-6.0% on plots 5 km away from any buildings or straw stacks. Here again the source of infestation may have been only the fields, not the village.

In 1953 webbing with accumulations of larvae which had emerged from the eggs was found in the 7th crop rotation field in forest land belonging to the Institute of Agriculture.

Table 5

Effectiveness of insecticides against young larvae (after emergence)

Insecticide	Time of count	Mortality rate (%)			
		1951	1952	1953	Average for three years
Hexachlorane	Before spraying	2.5	0.0	0.0	0.8
	One day after spraying	98.5	88.0	87.0	91.2
	Three days after spraying	100.0	98.5	89.0	95.8
DDT	Before spraying	1.6	0.0	0.0	0.5
	One day after spraying	96.0	81.5	60.0	79.2
	Three days after spraying	100.0	94.5	78.0	90.8
Control	Before spraying	2.0	0.0	0.0	0.7
	One day after spraying	4.5	9.0	0.5	4.6
	Three days after spraying	13.5	14.0	0 .0	9.2

Table 6

Effectiveness of insecticides against adult larvae

Insecticide	Standard amount used (kg per ha)	Number of live caterpillars per 100 plants		% decline of population
		Before spraying	Three days after spraying	
12% hexochlorane dust	30	32	8	75.0
Same	15	32	19	40.6
5.5% DDT dust	40	32	12	62.6
Same	20	27	30	26.0
Paris green	50	27	23	14.8
Control	—	27	26	3.7

It was not clear whether the moth laid its eggs in autumn among rye and wheat sowings or whether winter crops became infested in spring solely because the caterpillars were carried by the wind from fields where straw and chaff residues had been left scattered on the ground through the winter and from thatched buildings. A test was carried out in 1953 to clear up this question. In early spring (9 April) plots containing shoots of winter rye, winter wheat and wheat grass (Agropyron tenerum) were covered with isolators for 2 or 3 days before the appearance of the caterpillars on the roofs. Three isolators, measuring 50 x 50 x 50 cm and consisting of two gauze layers, were set on each crop, so as to protect the plants from attack by caterpillars blown from the roofs of buildings or from fields where there was a lot of accumulated straw and chaff.

It was assumed that if caterpillars were found on the plants under the isolators this would indicate that the moths had laid eggs on the winter crops in autumn. If caterpillars were not found under the isolators but were found on the sowings, this would mean that sowings of winter crops were not infested with eggs from autumn onwards. Numerous inspections of winter crops in autumn revealed neither caterpillars nor eggs on the plants, but the eggs may be laid on or in the soil, where it is difficult to detect them.

Caterpillar counts on the plants under the isolators were made 10 to 20 days after the final settling of the caterpillars from the roofs. Caterpillars were found on the plants covered with the isolators. This indicates either that the moths laid their eggs on the winter crop in late autumn or that the eggs from which the caterpillars emerged in spring had fallen into the soil along with the seed during the autumn sowing. In 1952 no eggs were detected among rye and wheat seeds; nor had any been found in 1951. Only in 1950, when the rye and winter wheat harvest was delayed, and the grain lay for a long time on covered threshing floors, did the moths settle on grain heaps and lay their eggs on the grain in the second half of August. Infestation of winter crops may therefore have occurred in autumn 1952. The wheat grass may have been infested solely because eggs had been laid on the sowings, for the seeds had been sown as far back as 1949, not in autumn 1952.

It can therefore be taken as established that the breeding sites of the stem moth are not only thatched roofs, as had been previously established, but also residues of straw and chaff scattered in the fields. Indirect infestation of winter crops and perennial grasses, from autumn onward, probably also occurs.

CONTROL

From what has been said above, it can be seen that the stem moth lays its eggs not only on thatched roofs but also in other places. Nevertheless, the importance of thatched roofs as very serious foci for the infestation of grain crops cannot be denied. The facts given above, showing that grain crops near thatched buildings are more heavily infested, indicate the great importance of such roofs in increasing the infestation of sowings by the moth.

An important step is to exterminate the larvae in thatched roofs. Zhukovskiy and Selivanova (1951) and Zhukovskiy and Petrova (1952) recommend clearing the webbing from the roofs and crushing it or digging it into the ground along with the larvae. This method gives unsatisfactory results, since many of the caterpillars make single rather than continuous webs and these cannot be destroyed by this means. The best method is to destroy the caterpillars by spraying the infested roofs with insecticides.

From 1950 to 1953 the Dokuchayev Central Chernozem Belt Institute of Agriculture (TsChP) tested the effect of dusting with 5.5% DDT and 12% hexachlorane during the emergence period. Thatched buildings, lofts, cellars and covered threshing floors in fields were dusted with these insecticides at the rate of 3-4 per square meter of infested surface and counts were taken at various times to discover the effect of the poisons. Two hundred caterpillars were taken at random from ten places for each test, and counted under a magnifying glass, to discover how many were still alive (Table 5).

The mortality rate from DDT and hexachlorane dusts was 79.2 to 91.2% in one day. On a three-year average, 79.2% of the caterpillars were killed in one day, and 90.8% in three days, by DDT — against 91.2 and 95.8% killed in one and three days, respectively, by hexachlorane.

The caterpillars cannot feed in the roofs. They usually die after seven days unless they fall on sowings. As a rule they do not stay long in the roofs, since the wind carries them into the fields. It is therefore necessary to dust sites where caterpillars have appeared, soon after their emergence from the eggs.

Once the caterpillars have penetrated the stalks they cannot be reached by insecticide. In 1950 and 1951 small plots containing such caterpillars were dusted with hexachlorane and DDT at the rate of 100 kg per ha, and with calcium and sodium fluosilicate at the rate of 50 kg per ha; no caterpillars were killed.

The larger caterpillars are sensitive to insecticides, and make frequent transitions from one stem to another; they can then be attacked with DDT and hexachlorane dust.

In 1950 we experimented with the use of insecticides against 3rd and 4th instar larvae on a 1-1/2 ha rye stubble plot, dusting as follows:

1. 12% hexachlorane, at a rate of 30 kg per ha on 2700 square meters,
2. 12% hexachlorane, at a rate of 15 kg per ha on 2600 square meters,
3. 5.5% DDT powder, at a rate of 40 kg per ha on 2700 square meters,
4. 5.5% DDT powder, at a rate of 20 kg per ha on 2700 square meters,
5. Paris green at a rate of 50 kg per ha on 2600 m^2;
6. Control — undusted plot — 1700 square meters.

The dusting was done on 14 May, and no sowing was done for three days after dusting (Table 6).

The hexachlorane and DDT were effective against the late-instar larvae but only in large amounts. Paris green was not effective, even at the rate of 50 kg per ha.

SUMMARY

The stem moth lays its eggs in thatched roofs, in small straw heaps scattered in fields, and in granaries.

Before spring sowing, the caterpillars emerge from the eggs, and are carried by the wind on cobwebs onto the shoots of winter grains and cereal grasses. They feed inside the stalks, destroying as many as five to nine stalks in the course of their lives. Five to eight days before earing, when the grain stalks and their ears are growing strongly, the caterpillars gnaw through the tips of the ears and also attack the stalks, causing the formation of white ear. At the end of May the caterpillars pupate in the leaves of grain crops, and in the first ten or twenty days of June the moths emerge from the pupae. The females lay their eggs in August and September, and die at the end of September.

Not more than 10% of the larvae survive and form cocoons. Most of them die in the first eight to ten days of feeding (from 35 to 93%). Many are killed on succeeding days by predator insects.

The caterpillars attack, not only rye and winter wheat sowings, but also many species of perennial cereal grasses (the wheatgrasses Agropyron tenerum and Agropyron cristatum, the awnless and upright bromes, meadow wheat grass, Siberian lyme grass, Roegneria canina), and also wild cereal grasses (quack grass, meadow grass, fescue).

Great damage is done by the caterpillars even before earing: 15-25.5% of the stalks are killed at the stage when the rye emerges into the tube; from 5 to 40% of the ears are gnawed through by the caterpillars; and from 0.5 to 5% of the stalks are "white-eared."

Control: 1) threshing floor, barn and other thatched roofs infested with the eggs must be dusted in early spring with 12% hexachlorane or 5.5% DDT powder; 2) infested sowings must be dusted with hexachlorane before the beginning of earing in rye (this is very expensive and must be used only in the extreme case of valuable seed-breeding sowings); 3) straw must be carefully collected from the

fields in autumn to prevent the formation of overwintering sites for the pest.

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MERVIA KUZNETZOVI, GEN. ET SP.N. (LEPIDOPTERA, NOCTUIDAE), A PEST OF LYCIUM RUTENICUM IN TURKMENIA

M. A. DARICHEVA

The Russian boxthorn (Lycium rutenicum), a shrub common in Central Asia, is a good sand binder and is also important as a honey plant. Its pest fauna has not been studied at all. This note describes a new genus and species of Noctuidae found on Lycium rutenicum by staff workers of the Institute of Zoology and Parasitology (Turkmenian Academy of Sciences) in the course of research work at a point in the Akibay sector of the Mariysk forestry farm 40 km north of Mary, at the boundary between a cultivated zone and an unreclaimed sandy-argillaceous semidesert. The boxthorn was heavily infested with the noctuids, which had done great damage to it.

The material obtained consisted mainly of larvae collected from the boxthorn and reared to the imago stage, and of moths captured in the open during 1959 and 1960. Observations on the development and behavior of the larvae were made under laboratory and natural conditions.

M. A. Ryabov (Leningrad) has confirmed that these noctuids belong to a new species and genus. The nomenclature used to describe the genital sclerites is based on the N. Ya. Kuznetsov system (1915).

The holotype and most of the paratypes of the new species are presented in the collection of the Zoological Institute of the USSR Academy of Sciences in Leningrad; some of the paratypes are in the collection of the Turkmenian Institute of Zoology and Parasitology. My profound thanks are due to V. L. Kuznetsov and M. A. Ryabov for their great help in this work.

MERVIA Daritsheva, gen. n.

The imago is medium-sized. Male antennae plumose, long; female antennae serrate. Unicolorous. Wing markings poorly defined. A grayish, small, reniform spot, slightly darker than the surrounding background, and two rows of dark points forming two transverse lines are distinguishable with difficulty. Along the outer margin of the wing runs a slightly darker indistinct band occupying the space between the outer line of points and the outer margin of the wing.

Similar to the genus Derthisa auct. This similarity is indicated by the presence of a developed epiphysis on the anterior tibia (Fig. 1), the absence of spines on the tibiae (Fig. 3), the peculiar coloration of the imago and the character of the pubescence on the male antennae. The relationship between these genera is further supported by the genital structure as indicated by the shape of the penis, the form of the valva, the sclerotization of the harpe and the oblate apex of the uncus. The size ratio of the fusculus to that of the labial palps also confirms that the newly-described genus belongs to this group (oral communication from M. A. Ryabov).

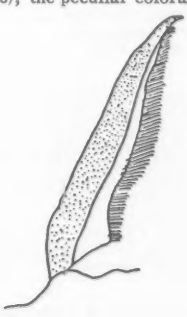

Fig. 1. - Mervia kuznetzovi, gen. et sp.n., structure of epiphysis.

The new genus is distinguished from Derthisa by the genital structure. The male genitalia are characterized by the structure of the valva. Cucullus wide; harpe articulated to the middle of the valva and well away from the dorsal margin; penis poorly sclerotized; uncus narrowing apically; inferior fultura not well developed. The fame genitalia are characterized by the poorly sclerotized ductus bursae of the bursa copulatrix near the ostium, the divergence of the ductus seminalis from the slightly rounded dilatation of the bursa copulatrix and the simple structure of the anal papillae.

Distribution: Turkmenian deserts.

Types of the genus: Mervia kuznetzovi Dar., sp. n.

Mervia kuznetzovi, sp. n.

Imago. Wing spread 26-28 mm in moths reared under laboratory conditions, 37-38 mm in those captured in the open under natural conditions. The general tone of the head, thorax, patagium and fore wings is of a gray-sandy color, created by a mixture of light, brownish, and black scales. Antennae light brown, long. In the female (Fig. 2 a) the teeth of the segments bear apical tufts of light setae one of which is longer than the rest. In the male the antennal segments are covered with long, slender hairs arranged in two rows, lighter toward the base (Fig. 2b).

The wing markings are not easily distinguishable. The grayish, reniform spot darker than the surrounding background and the transverse lines composed of points are poorly defined. Along the outer margin of the wing runs a slightly darker band.

The hind wings in the female are slightly darker than the fore wings, with a light base and fringe; in the male they are pure white. The abdomen and legs are a sandy gray. The large, strongly sclerotized epiphysis is 2/3 as long as the tibia (Fig. 3). In the larvae the fusulus is longer than the labial palps.

Male genitalia (Fig. 4a). Valva broad with parallel margins, hardly constricted at all apically. Apex of cucullus smoothly rounded, with setae and hairs over its entire breadth. Harpe strongly sclerotized, broad, almost flat, bowed inward and downward sickle-like and apically denticulate. Sacculus covered with setae in upper basal angle. Saccus triangular. Penis (Fig. 4 b) of uniform thickness, slightly curved, 2/3 the length of the valva. The sclerotization on its evaginated part is in the form of two small, barely

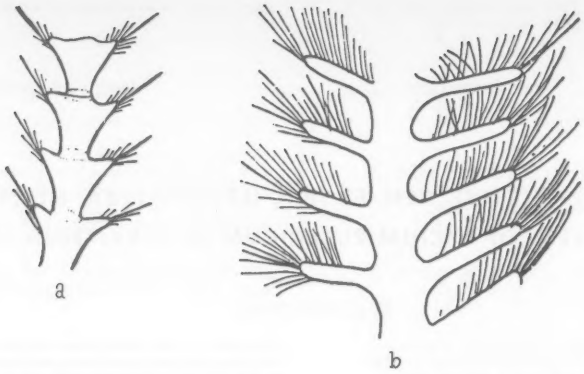

Fig. 2. - Mervia kuznetzovi, gen. et sp. n., structure of antennal segments: a - female, b - male.

Fig. 3. - Mervia kuznetzovi, gen. et sp. n., general view of fore leg.

distinguishable spines. Uncus decurvate (Fig. 4c) in the shape of a beak, its apex slightly dilated. Inferior fultura slightly sclerotized, not well developed.

Female genitalia (Fig. 5). Ostium bursae inferiorly protected by a narrow, slightly sclerotized semi-annular antevaginal plate and opening in a faveate depression. Post-vaginal plate weakly sclerotized, barely perceptible. Posterior margin of ring of eighth segment with short setae. Ductus bursae weakly sclerotized throughout, the sclerotized folds in some individuals being displaced into the region of the bursa copulatrix (Fig. 6), probably because having been reared under laboratory conditions these individuals had not been fertilized. Bursa copulatrix globular, slender, membranous. The ductus seminalis runs from the bursa copulatrix well away from its ductus and from the small round dilatation which is slightly separated from the bursa. Anal papillae short, broad, covered with setae and hairs, without apical excavation. Apophyses long, the posterior ones being half as long again as the anterior.

Material: the species has been described from 10 specimens reared from larvae found on boxthorn and from 2 captured in the open. Holotype, 1 male, Akibay, 40 km north of Mary, 14 October 1960 (M. Daricheva). Allotype, 1 female, ibid., 14 October 1960 (M. Daricheva). Paratypes: 2 females, ibid., 13 October 1960 (M. Daricheva); 4 females, ibid. 7, 11 and 13 October, 1960 (M. Daricheva), 9 October 1959 in the open (M. Gel'dyyev), 1 female, Ibid., 19 April 1960, in the open (M. Daricheva); 1 female near Bayram-Ali, 1907 (K. Demokidov). Some paratypes imperfect.

Distribution: sandy argillaceous deserts of Turkmenia

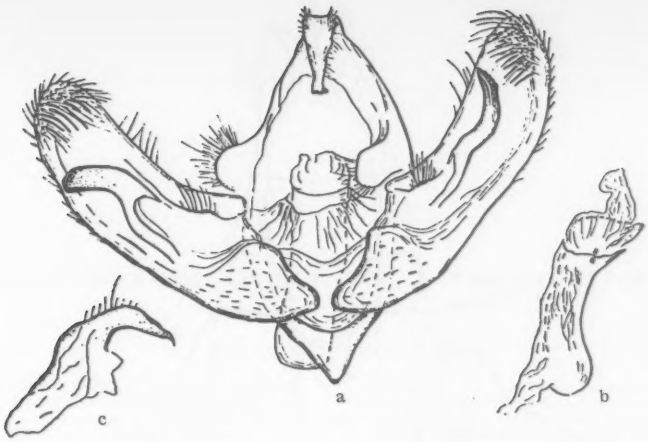

Fig. 4. - Mervia kuznetzovi, gen. et sp. n., a - male genitalia, b - structure of penis, c - structure of uncus.

Fig. 5. - Mervia kuznetzovi, gen. et sp. n., structure of female genitalia in typical individuals.

(vicinity of Mary and Bayram-Ali). The species is named after V. L. Kuznetsov, who did much for the study of the lepidopterous fauna of Western Turkmenia.

Biology: The noctuid is associated with Lycium rutenicum. In 1960 it was a mass species. In early spring (second half of March) up to 30-40 larvae of various instars, measuring 5 to 10 mm, were found overwintering in the soil under each boxthorn bush. The larvae are nocturnal. In the morning they can be seen still feeding on the foliage of the boxthorn until sunrise, when they return to the soil. The early instars have an earthy coloration with pronounced white markings. Cuticle bare, delicate, slender, translucent. In the full-grown larvae the general background coloration is light olive with a brownish tint, which becomes more concentrated in the distal abdominal segments. The white markings consist of 3 longitudinal milky-white lines running along the dorsum, the middle one being relatively even and narrow (less than 1 mm) and of 2 other lines emitting, as

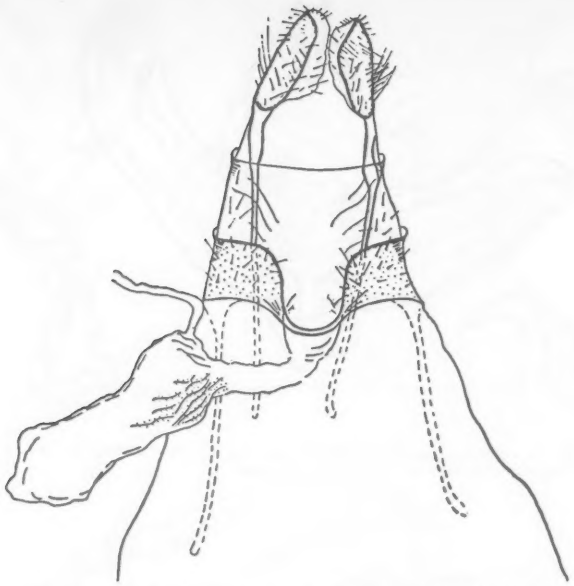

Fig. 6. - Mervia kuznetzovi, gen. et sp. n., variation in structure of female genitalia (displacement of sclerotized folds into the region of the bursa copulatrix.)

it were, small transverse marks forming the simulacrum of an angle at the boundaries of the segments. Lateral bands situated above the legs are composed of peculiar markings resembling the letter gamma (the lines occur only on the abdominal segments). Head large, pale yellow. Prothoracic shield distinct; its coloration light yellow with black markings. Legs colorless. Larvae pupate in the soil, where they make compact, smooth, brittle cocoons of a light gray color, greatly resembling sheep excrement in shape and color. The walls of these cocoons are 0.5-0.6 mm thick, 13-15 mm long and 7-10 mm in diameter. The larvae withdraw for pupation throughout May; having made the cocoon, the larva loses its coloration and remains in this condition for about four months. Under laboratory conditions the larvae pupated 12-15 September. The pupae are very delicate, soft and pale yellow.

The moths emerge from 7 to 15 October. One female was captured in the open under natural conditions on 9 October 1959, and another on 19 April 1960. It seems that under natural conditions the flight period is prolonged. Emergence starts in autumn, ceases during the cold period of winter, and is resumed in spring. The species has one generation. A few hours after emerging under laboratory conditions, the unfertilized female moths each laid a number of large, light-yellow, round eggs, and, after one or two days, perished with the ovary full of eggs. The males lived longer than the females. More detailed study of the biology of this species is desirable.

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THE BIOLOGICAL BASIS FOR CONTROL OF POULTRY ECTOPARASITES

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For poultry farming, as for other branches of livestock production, new possibilities of development have appeared in recent years and output can be greatly increased even in the immediate future. The trade increase in these products is due primarily to the enlarged network of specialized poultry farms, the absolute increase in poultry stocks and the improvement in breeds. Much now depends on the provision of an appropriate range of animal husbandry and veterinary assistance and on steadily bolstering the normal conditions of poultry maintenance and sanitation with zootechnical and veterinary precautions. These include, in particular, control of the mites, ticks and wingless insects ectoparasitic on poultry, some of which are continuously associated with their hosts throughout their lifetime, while others, in nature, develop entirely outside their hosts, and attack only temporarily, in order to feed. Because of these biological peculiarities, a rather larger number of basic problems is involved in the practical study of temporary than of permanent parasites: it takes longer to work out a biological basis for streamlined control of temporary parasites and to test practical control measures.

Of the poultry parasites considered in this paper the following can have economic significance: the feather mites (Analogesoidea), the poultry lice (Malophaga), the blood-sucking mites (Gamasoidea), the chigger mites (Trombiculinae), the fowl ticks (Argasidae and Ixodidae), the bed-bug (Cimex lectularius L.) and fleas (Aphaniptera). Feeding on skin derivatives or blood, the parasites directly attack the host's body integument, and by running about among the feathers, injuring the tissues and introducing mucous secretions they set up irritation and itching which are the reason for restless behavior in fowls. These outward symptoms, are not an invariable accompaniment even of heavy parasite infestation: they do not appear, for example, in sick birds. The effect of parasites depends on their specific peculiarities (type of feeding, properties of the mucus glandular secretions, movement, population) and on the physiological characteristics of the host (individual sensitivity, resistance, general condition). Heavy parasite infestation can have a serious effect on the general condition, particularly of young birds, sometimes with fatal results. Gramming and fattening are adversely affected through loss of appetite; and egg production, the growth of the chicks and brooding suffer. The host's protective reaction to the irritation and itching caused by the parasites can cause traumatic injuries to the skin (by the beak, for example) which provide ready pathways into the organism for pathogenic agents causing secondary diseases. Moreover, certain ectoparasites are known as carriers of the agents of a number of poultry diseases. In the USSR, for example, the bluebug Argas persicus Ok. transmits chicken and goose spirochaetosis, chicken, goose, duck and turkey aegyptianellosis and chicken grahamellosis. Such parasite carriers can acquire even greater local economic importance, particularly when they breed on a mass scale, unless steps are taken in good time to restrict their breeding.

Practical control measures against poultry parasites will be economical and effective if they are worked out on a biological basis so that they have a clear-cut purpose and are then carried out according to plan.

PERMANENT PARASITES

The biological basis for the control of permanent parasites is determined by investigating their fauna, the duration of their growth stages and their sources, together with research on the effectiveness of parasiticides. Their harmfulness can be drastically reduced in a relatively short time because their entire development takes place on the host's body.

Regional fauna studies. This is done by regular inspections on the farm and by reconnaissance inspections on the specialized and nonspecialized poultry farms in a given area. All-the-year-round inspections at intervals of 7-10 days, taking into account the condition of the birds and the conditions under which they are kept, reveal the parasite fauna at a given farm in the light of seasonal variations. A single reconnaissance inspection within a given operational area is more indicative in the winter-spring period, when infestation, by poultry lice, for example, will be highest. It is best to combine seasonal station and reconnaissance inspections in order to get the most comprehensive picture of the number of species making up the parasite fauna in the area concerned. Not less than ten to fifteen birds are selectively chosen at each inspection. To get a comprehensive faunistic picture the following recommendations should be kept in mind as well:

1) As far as possible, birds of different age groups should be inspected.

2) All parts of the body should be carefully inspected since there is a known localization of parasites on the host. In chickens, for example, the wing louse Lipeurus caponis (L.) lives primarily on the under-surface of the primary wing feathers, where it often hides between the barbules near the shaft; Cuclotogaster heterographus (N.) is found mainly on the head and neck feathers; Eomenacanthus stramineus (N.) infests the whole body, preferably the skin and Knemidocoptes mutans (Rob.) usually lives under the horny scales on the unfeathered part of the legs.

3) Efforts should be made to obtain as complete a collection of parasites as possible, not confined to a few individuals or merely to the largest, since some parasite species are comparatively small, sparse and not numerous.

Essential information on methods of inspection, collection and preservation is available in specialized manuals on particular groups of parasites (Blagoveshchenskiy, 1940, 1959; Dubinin, 1951).

Studying the duration of the growth stages. The incubation (embryonal) period is determined by means of daily observations, first on groups of the eggs of known species, marked on identified feathers, with experimental mass infection of the bird (with males and females of the parasites for half a day to a day, followed by treatment with non-ovicidal preparations) and secondly on eggs taken along with feathers from the host or laid on the feathers, when the adult parasites are reared under controlled temperatures. In case of difficulty in establishing the species of the marked eggs, these can be compared with mature eggs which have been identified by dissecting females of all the species of ectoparasites living on the host concerned. Observations on the post-embryonal growth periods can be made by experimentally infesting a large number of birds with newly hatched larvae of a known parasite species; this method, however, permits determination only of the minimum

duration of individual stages or instars and entails rearing newly hatched larvae in an incubator. The main prerequisites for successfully preserving and rearing the parasites and their eggs in an incubator are favorable temperature and moisture conditions, which can be established experimentally by determining the hygrothermal conditions of the localized environment of the host's body, and the supply of the parasite's particular food.

It is important to learn the duration of the parasites' stages and instars, in order to know when treatment must be repeated in cases when the preparations used do not possess a residual action exceeding the duration of the incubation period and are not ovicidal.

Modes of attaching to hosts. These must be taken into account for control purposes. Direct attachment due to contact with the host can occur through migration (crawling) from adult to young birds during the nesting period, when contact between the birds is most prolonged, from male to female and vice versa during mating or from one individual to another in any other circumstances in which the birds come into contact (for example in a flock or colony during feeding, resting, sleeping or nesting). Indirect parasite attachment is not due to direct host contact. The parasites can attach their own or an alien host under a variety of conditions: active crawling (for example along perches, in dust baths), contact of the birds with shed or plucked feathers carrying parasites and their eggs (from which larvae may hatch out if conditions are favorable), phoresy, from equipment (nesting baskets and so forth), transfer from the clothing of staff and so on.

Investigation of the effectiveness of parasiticides. This amounts to experimentally checking on parasiticides which have been approved as highly effective against parasites and harmless to the birds in each typical locality, with various methods of application. A review of the literature (see end of paper) shows that it is most important to have a comparative assessment of the effectiveness of a particular control procedure, based on allowance for the properties of the parasiticide and its effect on the parasites and on the hosts under experimental and actual farm conditions. This means setting up: 1) laboratory experiments (direct and control) to discover the effect of the parasiticides on the parasites and their eggs under hygrothermal conditions (in a constant temperature chamber) approximating those of the host integument, 2) experiments on the effect of parasiticides on parasites situated on the host itself (when the birds are kept in cages) to establish the effectiveness of the preparation and investigate its pharmacology (that is, determine whether it is harmless or injurious to the bird and, if it is effective, whether it is also harmless), 3) similar experiments on a large group of birds under the conditions in which they are normally kept.

There are two known methods of applying parasiticides against poultry parasites. The first is the dry method, in which the parasiticide is used in dust form and applied by hand dusters or simply by hand. This is suitable at any time of the year, in all weathers, and is obligatory in treating sick and very young birds. The second, the wet method, entails applying the parasiticides either in the form of aqueous solutions, suspensions or emulsions by spraying with hand or aerosol instruments, washing and bathing, or in ointment form. This method can be used only in the warm season and on dry, windless days and should not be used on sick or very young birds; it is also unsuitable for aquatic birds. Bathing is a better method of application than dusting, saves parasiticide, especially when a large number of birds is treated at a time, speeds up the treatment and obviates certain inconveniences for the operator. If the bird is bathed for not longer than 20-30 seconds the feathers will not be thoroughly wetted, for the bird dries very quickly in warm calm weather. It is very important, however, that the parasiticide should not have a greasy or alkaline composition – that is, that it should not pollute or soak the feathers and should not harm the skin. If the parasiticide used has no persistent and ovicidal properties, treatment must be repeated once or twice whatever the method of application. Repeated treatment is necessary once a new generation of parasites has hatched out from eggs laid before the first treatment and before they have reached sexual maturity (that is, the capacity to mate and lay eggs). In order to decide when the treatment must be repeated the incubation period and the duration of post-embryonal development up to sexual maturity must be established experimentally.

As there is some variety in the methods of direct and indirect infestation, which allows the parasites to spread rapidly and makes it possible for some to escape selective treatment, at any rate on birds which are only slightly infected, it is necessary to treat each bird separately. It is recommended that this be done at the end of the summer or the beginning of the autumn, preferably before the birds molt, when the weather is usually suitable for the wet method and most of the young birds have reached a certain maturity, while the surplus birds have been eliminated. If summer or early autumn treatment has not been carried out the birds should be treated in autumn by dusting. The wet method (ointments, emulsions, solutions) is suitable against the leg mite Knemidocoptes mutans (Rob.), which causes "leg mange" in chickens. The fumigation method (Panasenko, 1936, 1937) still needs further testing.

As different parasite species are variously localized treatment must of course be done carefully. Complete treatment, covering the entire body surface, is the most effective. Local treatment, covering a part of the body, is possible only when the host is infested by one parasite species, limited in its localization (for example, leg mites Knemidocoptes mutans on chickens).

The dust bath cannot in itself, without special general treatment of the bird, be regarded as an effective measure for limiting infestation by parasites, if only because not all the birds will "bathe". The bath is of some help in mechanically contributing to partial disinfestation. On the other hand, it must be remembered that dust baths can be a potential source of infestation. They will be more effective if this danger is obviated by the addition of a parasiticide to boxes containing road dust or sand and ash or to heaps of dust or sand in the runs and if these are placed as an additional prophylactic measure. For chemical parasite control preparations meeting the following basic requirements could become widely used: 1) strong action and high persistence, 2) harmlessness to animal organisms, 3) simple manufacture, 4) simplicity in use, 5) low cost.

Effective preparations containing no oily or corrosive matter – preferably long term parasiticides, for example of the sodium fluoride type, which obviate the necessity for repeated treatment and can be used in dust and aqueous solution form – are undoubtedly the most economical. Further work in the direction of finding new parasiticides is particularly desirable.

It is necessary to bear in mind that different parasite species may not be uniformly susceptible to different parasiticides and that resistance to parasiticides may develop in the parasites. It is also necessary to bear in mind the effect of the parasiticide at different stages of the parasite's development.

TEMPORARY PARASITES

Control of temporary poultry parasites is more difficult, since the parasites develop outside the hosts. The biological information essential as a basis for control is obtained by investigating the fauna and distribution of the parasites by situation, their host range, the active attack period, the duration of feeding, how long they can live without feeding, the ways in which they reach their hosts, and the effectiveness of parasiticides.

Study of the fauna and distribution by situation. This is done by seasonal inspection of the poultry (see above) and of the poultry yards, runs and so forth. In inspecting a poultry yard all parts must be examined (walls, roof, perches and so forth) and particular attention must be paid to cracks and crevices in which mites and ticks (for example Dermanyssus gallinae L., Argas persicus Ok) and the bedbug (Cimex lectularius L.) can take refuge. As it is usually at night that these parasites attack the host for feeding, there is often difficulty in noticing during the day time that a yard is infested, particularly if the parasite population has not yet become numerous. On careful daylight inspection a yard infested with mites, ticks or bugs is found to contain their excrement, which stands out in the form of white and black spots (Dermanyssus gallinae L.) or small black patches (for example Argas persicus Ok.) near cracks and Crevices and in spider webs in corners where the larval skins of A. persicus Ok. may occur, even in large numbers. Night inspection of infested poultry yards, with artificial

light, is effective, as it is easy to notice parasites crawling along the walls and perches. Along with the poultry yards, trees (cracks, areas under loose bark) must also be inspected, as well as other objects used by poultry as night perches, the nests of pet birds, dwellings and other types of farm buildings, and nest litter and dust covering the floors. Inspection of the birds and the places where they are kept on the farm and outside it will give a fairly good idea of how far the poultry yards are infested with mites ticks, bedbugs or fleas and will reveal the nearest foci of these parasites to the yards. Information on inspection, collection and preservation methods can be found in papers by Pavlovskiy (1927, 1928, 1931a), Bregetova (1956), Vysotskaya (1956), Serdyukova (1956), and Blagoveshchenskiy (1957).

Range of Hosts. Here study is based on inspections of domestic and wild animals. It is known, for example, that the hosts of Argas persicus Ok. include not only poultry but also a number of wild bird species, including such tame birds as sparrows, pigeons and the like, that the flea Echidnophaga gallinacea Westw. is a parasite both on poultry and on certain other domestic and wild animals, as is Ceratophyllus gallinae (Schr.). In organizing the control of temporary parasites, therefore, their secondary (man-made) inhabitation areas (poultry yards and other livestock buildings) and possible primary biotopes (birds' nests) also deserve attention. In practice it is recommended that poultry yards and runs be situated in places free from trees, that nests infested with parasites be periodically destroyed and that trees used by birds as night perches and for nesting be treated with parasiticides.

Attack periods. In practice poultry yards can be under continuous parasite attack both in the more southerly distribution areas, where temperatures are suitable for their winter development and also in the more northerly regions, if the temperature maintained in the poultry yard during winter is suitable. The period of active attacks by Ixodidae and chigger mites depends on the development cycle of the species and is established for each typical location by inspecting the birds and their runs. In the USSR the Ixodidae found on poultry include Rhipicephalus turanicus Pom. (fowl), R. bursa Can. et Fanz. (geese), Hyalomma plumbeum (Panz.) (fowl, turkeys and ducks). Chigger mites, parasitic only in the larval stage, are characterized by a specific seasonal activity, like the ticks. Where Ixodidae and chigger mites are numerous it is recommended that poultry, particularly young birds, should not be let out to feed in places likely to be infested by the parasites during their active period.

Duration of feeding (sojourn) on host. This is determined by experimentally feeding the parasites on the host or by daily observations on parasites found feeding on the host during a known portion of the day. The duration of feeding by temporary parasites varies within definite limits. Argas persicus Ok. larvae, for example, are found on the host for bloodsucking for periods varying from five to ten days, the nymphs and adults for a few minutes to two hours. The possibility of a comparatively prolonged stay by temporary parasites on their hosts is a basic reason for arranging quarantine and treating all birds newly arriving on the farm so as to prevent the importation of parasites.

Duration of starvation period. Here, study is based on laboratory experiments in keeping parasites (both collected in poultry yards and reared for the purpose in the laboratory) without food and on observations on unused infested poultry yards. Temporary parasites have a pecular ability to endure prolonged starvation, which has been elaborated in them in the process of evolution as an adaptation to the peculiarities of the host biology. The fowl tick Argas persicus Ok., for example, can go without food for two to three and a half years, and its larvae for more than one year. Bloodsucking parasites are thus able freely to tolerate a more or less prolonged absence from the host. This indicates that birds must not be transferred to a summer type of yard infested, for example, with Argas persicus Ok., and left there from autumn to spring, unless the yard has first been treated. The ability of the parasites to survive for a long time without food and their habit of hiding in cracks and crevices are on the one hand good reasons for regularly treating infested poultry yards, and, on the other hand, for designing them properly and observing the rules of poultry keeping. The number of treatments applied depends on the method used, on the care with which the operation is performed and on the quality of the parasiticide used. It is desirable to construct fairly roomy, dry, light and well-ventilated poultry yards with easily dismantled and portable perches, nests and feeding troughs. This is important for convenience in the regular tidying-up, disinfestation and periodic repair and for the essential changing of perches and nests, in other words, for measures aimed at eliminating the places inhabited by mites and ticks (Dermanyssus gallinae L. and Argas persicus Ok.). Creating normal conditions for keeping and feeding the birds keeps down parasites and prevents their development.

Attainment of host. The purpose in studying the ways in which the parasites attain their hosts is to discover peculiarities which must be kept in mind in organizing control. The attachment of these parasites is effected actively, by migration over short distances, and passively during the transport of live and slaughtered birds, when the parasites are conveyed in the means of transport or in bird boxes and baskets, or brought in by wild (especially by pet) birds or in the clothing of farm workers. The indication is that to prevent the parasites from spreading, attention should be paid to the need for veterinary inspection and compulsory quarantine (with individual treatment of all newly arrived birds and disinfestation of transport), and for periodic inspections of the poultry yards, destruction of infested nests of pet birds and treatment of mite-and thick-infested trees used by the birds as resting-places and night perches and of other parasite-infested places.

Study of the effectiveness of parasiticides. This means experimentally verifying and comparing the recommended procedures (dry, wet and fumigation methods) and control measures (different forms of application) in terms of the effect on the parasites, particularly in crevices and cracks difficult of access. Such testing involves making provision for prolonged treatment, followed by the weathering of the structures treated so as to make sure that they can subsequently be used for birds with complete safety. Regional testing is required, in particularly for parasiticides to be recommended for use in poultry sheds (hexachlorane, DDT, activated creoline, Chlorpicrin, hexachlorane smoke canisters, pyrethrum).

A system of poultry parasite control which takes into account the above-mentioned biological rationale must include both extermination of the parasites, on the birds and in their hiding places, and also prophylaxis against infestation. The seasonal timetable and the joint use of combined and differentiated precautions must be coordinated with farm routines and veterinary rules.

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ON THE POSSIBILITY OF CHEMICAL CONTROL OF THE "KARAKURT" (STEPPE SPIDER) (LATODECTUS TREDECIMGUTTATUS ROSSI)

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Prendel' (1953) indicates that the "Karakurt" was detected in the neighborhood of Odessa as long ago as 1827 by Krinitskiy. Since 1952 an increase in the population of this spider, accompanied by the infestation of large areas near Odessa and the southern districts of the province, has been noted.

A great variety of sites is infested by steppe spider in these parts. This xerophilous spider is persistent and numerous in the Black Sea marshy beaches which are its "survival sites" and consist of sandy or level salt-marsh areas, as a rule, with low, usually not very thick vegetation. Trees and shrubs are rare. The predominant plant species are Salicornia herbacea L., Suaeda altissima Pall. and S. maritima D., Gypsophila trichotoma Ewnd. and certain others. Many Orthoptera are usually found (Sphingonotus coerulans L., Oedaleus decorus Germ., Aiolopus thalassinus F.).

During a period of mass outbreak, however, the spider is to be found in many other locations as well: in gardens, in strawberry beds, on the shoulders of highways, in hedges, on the beds of tramways and railway lines, under the rails, under scattered stones and even in the Odessa parks.

Under the conditions prevailing in Odessa all adult females of the steppe spider usually perish in November, but inactive, half-dead females can sometimes be found even in mid-December. The males die much earlier, usually in August. Young, over-wintered spiders can be observed emerging from the cocoon, crawling and migrating, depending on the weather, during the first twenty days of May. Oviposition starts not earlier than the first third of July. A little while before this the bite of the female becomes dangerous to man.

From 10 to 25 cases of "steppe-spider" poisoning are recorded annually by the medical authorities in Odessa and certain neighboring districts and, in addition, a number of cases go unrecorded. The clinical course of the illness after a spider bite varies, but the disease is often severe.

"Karakurt" poison has so deep an effect on the organism that cases of lowered capacity to work have been recorded even several years after the patient has been bitten. As the principal wave of bites coincides with the season of intensive agricultural work and also with the health resort season, people working in the fields or resting in sanatoria, pioneer camps and the like are often subject to attack. The importance of taking all possible preventive measures in good time is therefore clear.

The literature deals inadequately with control, particularly extermination. In recent years, therefore, interested organizations have been carrying out operational tests on "Karakurt" control measures in the vicinity of Odessa and the coastal districts.

In places where there is a possibility of human contact or where the spider abounds near dwellings, a chemical method is used.

In 1954 Ye. A. Volyanskaya successfully used a 15% hexachlorane emulsion at the rate of 1 to 1-1/2 per square meter against the steppe spider in the vicinity of Odessa. Later, under Pul'ver's direction, hexachlorane emulsion was used in various concentrations for chemical treatment under operational conditions, with mechanized equipment (a motor sprayer, a spraying tram with tank and Po-2A and AN-2 aircraft). Airborne spraying with a 15% hexachlorane emulsion at the rate of 0.6 g per square meter (AN-2 aircraft) also gave a high mortality rate (96%).

In 1957 Selens made laboratory and field tests with certain liquid and powder chemical poisons and in 1958 we jointly undertook laboratory and field experiments specifically designed to exterminate juvenile and sexually mature spiders. The results are given below.

Laboratory tests on exterminating the juvenile stages of the spider were performed on 9 and 10 June 1958 with dust preparations of pyrethrum, Vofatox and sulfonated ester. Active fourth, fifth and sixth instar juveniles and sexually immature males were placed separately, six specimens at a time, in 150-square meter jars containing a little sand at the bottom. The tests were repeated in each case. Amounts of 0.35 g of the dusts were poured on to gauze covering the jars. The gauze was then agitated so as to shower the dust on to the spiders.

It was established that treatment with pyrethrum caused total death of the juvenile steppe-spider instars to set in after 27 min; the comparable times were 1 hr 45 min for sulfonated ester and 12 hrs for Vofatox (or even 15-17 hrs. in some specimens). In the Vofatox test the spiders were seen to be suddenly stimulated immediately after the dust was applied; loss of activity set in 45 to 50 min later but death was slow. The younger instars perished more quickly than the rest.

Field experiments were performed near Odessa, on the Kuyal'nitskiy liman barrier beach, where sands alternate with salt marshes. The sand contains large quantities of shell fragments (Cardium, Venus, etc.). The vegetation forms a continuous cover only in rare cases. We chose a sector where it was slightly thicker than elsewhere, on a level area on relatively humus-rich soil. Salicornia herbacea and Suaeda altissima predominated.

Extermination tests on juvenile spiders were tried here in June with pyrethrum and sulfonated ester and later, in September, with hexachlorane, Vofatox, Anabadust and also pyrethrum and sulfonated ester dusts.

In June the experiments were made on plots of 100 square meters; in September on plots of 500 square meters, except for the Anabadust. All the tests were repeated once.

It must be emphasized that all the plots selected, both those treated and the control plots, were exceptionally homogeneous. The preparations were applied only by dusting. For this purpose we used gauze bags fixed to a horizontally stretched cord and spaced 1-1/2 m apart. This cord was continuously agitated by two men. During both tests the weather was exceptionally good (warm and calm).

Two or three hours before the treatment a count of the nests containing live spiders was taken. The count was taken again the day after treatment and repeated a few days later. After the field tests on the juvenile instars a further count was taken one month later.

To discover the influence of the preparations on the eggs and spiders in the cocoons we collected a proportion of these after treatment and dissected them in the laboratory during the next seven days. The results shown in the table give a clear picture of the effects of each preparation.

Table 1

Field tests on extermination of juvenile "karakurt" stages

Chemical preparation	Area square meters	Rate of application per ha	6/20/58 before treat.						21 June 1958, 1 day after treatment												Mortality (%) [1]		Additional count, 26 July 1958
			Live females			Live males	Empty lairs		Live females			Live males	Dead females			Dead males		Empty lairs	Females	Males	Live females in lairs
			Juvenile instars						Juvenile instars				Juvenile instars								
			V	VI	VII				V	VI	VII		V	VI	VII						
Pyrethrum (powder)	100	30 kg	18	23	15	14	8		—	1	1	—	17	21	14	14	1	3	3	—	9	96.4%	100%	10
Sulfonated ester (30% powder)	100	35 kg	12	21	13	19	4		3	6	8	3	8	17	10	14	2	1	4	1	7	63.0	84.3	11
Control	100	—	9	17	12	11	2		8	17	15	10	—	—	—	—	—	—	—	—	1	Incr. 11%	Incr. 9%	18

[1] The mortality rate was computed from the ratio of live spiders detected after treatment to live spiders detected before treatment.

The most striking point to be seen from Table 1 is the high mortality rate of the males as compared with the females. Observations on the spot showed that the males died more rapidly. It is very interesting that pyrethrum killed the spiders even when applied at a comparatively low concentration (30 kg/ha).

From direct observation immediately after treatment it was established that in some cases total death of the juvenile stages poisoned by pyrethrum set in after only 45 min, whereas it took at least 4 to 5 hrs before this happened when sulfonated ester was used. It was also noted that the younger instars perished first.

When the experimental plot was visited again, on 8 July 1948, it was found that during the migration (mating) period females moved into the treated plots from the surrounding area. This would also seem to explain the abundant settlement of the experimental plots by sexually mature females roughly one month after the experiments (count of 26 July).

The second experiment, on the extermination of adult spiders, was performed near the same plots on 15 September 1958. As in the first experiment, lairs containing live spiders were counted 2 to 3 hrs before treatment. The count was repeated 1 day and 5 days after treatment. In addition, observations were made on the spiders in cocoons collected from the treatment plots. It can be seen from Table 2 (counts taken 1 days and 5 days after treatment) that hexachlorane and pyrethrum were the most effective of the poisons (97.7 and 95.3% mortality respectively), but mortality was high also when sulfonated ester was used. Except with Vofatox and Anabadust it was noticed that the mortality rate increased slightly with time.

We would emphasize that in many cases when it is undesirable to use hexachlorane (gardens, sanitation establishments and the like) the spiders can be destroyed with pyrethrum, which is known to be nontoxic to man and warm blooded animals and has no phytocidal properties.

It is noteworthy that the organophosphorous poisons tested by us, Thiophos (Selens, 1958) and Vofatox, produced no appreciable effect. Anabadust also has too low a toxicity (5%) for use against this spider.

The effect of chemical poisons on the eggs and on the spiders in cocoons should be considered separately. At the time of treatment the nests contained 3 to 5 cocoons. After treatment (20 September) several cocoons were selectively taken from each plot (Table 3) and dissected during the next week. As was to be expected, hexachlorane and sulfonated ester had penetrated the envelope of the cocoon, so that eggs and even spiders were destroyed, although only in certain cocoons.

CONCLUSIONS

1. Serious attention must be given to the use of chemical poisons as part of the extermination measures to be applied when there is a mass outbreak of the steppe spider and when the spider sppears near dwellings.

2. When chemicals are used it is imperative to cover immediately the entire infested area within a radius sufficient to protect the sector concerned from resettlement during migrations of the spider. This naturally means using powerful mechanized equipment, including aircraft.

3. Laboratory and field tests have shown that at a relatively low rate of application (30 kg/ha) hexachlorane and pyrethrum are the most effective (97% and 95% mortality respectively).

4. A drastic saving in the consumption of commercial BHC can be achieved if hexachlorane is used in dust form (0.36 g per square meter against 1-1.5 g when emulsion is used for large-scale extermination control).

5. The fact that we found pyrethrum highly effective both in the laboratory and in the field tests, despite the known instability of this preparation, is extremely interesting. Further experimentation with this preparation, under other ecological conditions, is desirable.

6. The use of pyrethrum in "karakurt" control is of

Table 2

Field experiments on the extermination of sexually mature "karakurt" females and their cocoons

Chemical preparation	Area square meters	Rate of application per ha	Before treatment 15 Sept. 1958		1 day after treatment 16 Sept. 1958				Mortality (%) [1]	Second count (20 September 1958)				Mortality (%) [1]
			Live females in lairs	Empty lairs	Live females in lairs	Empty lairs	Dead females	Dying females		Live females in lairs	Empty lairs	Dead females	Dying females	
Control	500	—	47	1	46	2	—	—	2.1%	45	3	—	—	4.3 %
Hexachlorane (12%- dust)	500	30 kg	43	—	7	10	24	8	83.5	1	9	7	1	97.7
Vofatox	500	30 kg	45	2	19	20	7	6	65.6	16	17	3	8	64.5
Sulfonated ester (30%-powder)	500	35 kg	33	—	11	3	18	6	66.7	7	3	5	1	78.9
Pyrethrum (powder)	500	30 kg	42	—	4	12	28	4	90.5	2	13	4	5	95.3
Control	500	—	21	2	21	2	—	—	0.0	20	3	—	—	5.0
Anabadust (5%)	100	30 kg	12	1	4	3	2	6	66.7	4	4	3	2	66.7

[1] The mortality rate was computed from the ratio of live spiders detected after treatment to live spiders detected before treatment.

Table 3

Effect of various chemical poisons on "karakurt" eggs and spiders in cocoons in field experiments (Table 2)

Chemical preparation	Number of cocoons opened from 16 to 23 Sept. 1958					
	With eggs			With spiders		
	Found					
	Live	Dead	Partial death	Live	Dead	Partial death
Control	18	—	—	29	—	—
Hexachlorane (12%- dust)	14	2	6	27	2	5
Vofatox	17	1	—	32	—	—
Sulfonated ester (30%-powder)	12	1	—	39	4	1
Control	10	—	—	28	—	—
Pyrethrum (powder)	9	—	—	14	1	—
Anabadust (5%)	8	—	—	11	—	—

special interest, as this preparation can be applied in areas where it is impossible to use chemicals toxic to man and warm-blooded animals (gardens and so forth).

7. Phenological indications suggest that chemical treatment is best applied during the period when there is a mass appearance of female spiders, sexually mature or on the point of reaching sexual maturity, before the appearance of the egg cocoons; in other words, at the end of June and in the first ten days of July (under Odessa conditions).

8. Further study of "karakurt" control methods is desirable; in particular, it would be of interest to find out whether chemical treatment can be combined with biological. This would entail appropriate investigation of the biocenoses of "karakurt" situations.

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COLLEMBOLA FAUNA OF ETHIOPIA

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A large number of papers on species of Collembola from Africa, particularly the eastern part of the continent, has appeared in recent years (Delamare-Debouteville, 1953; Salmon, 1954a, 1954b, 1954c, 1954d, 1954e, 1955, 1956), but since the old works and the recent information are all based on scanty and, in the main, chance material, there is as yet no comprehensive picture of the Collembola fauna in particular regions of Africa.

We too had at our disposal only the small collections brought from Ethiopia by D. M. Shteynberg at the end of 1959. In addition I have reviewed the Ugandan and Kenyan Collembola material acquired by V.A. Dolgel and I. I. Sokolov in 1916 and worked on by Yu. A. Filipchenko. Great difficulties were encountered in working on our material, because in many cases it was impossible to use the old descriptions owing to the absence of drawings and the inaccuracy of the diagnoses and also because certain specialized works were not available. As a result, a part of the Collembola material has remained unidentified to the species level (Lepidocyrtinus sp. - 2 species; Anurida sp., Pseudachorutes sp., Ceratrimeria sp., and Onychiurus sp.).

Of the identified material (9 species), some belong to species with a very wide distribution (Lepidocyrtus cyaneus Tullb., Ceratophysella denticulata Bagn., Frisea mirabilis Tullb.) 3 species are characteristic of East Africa, (Paronella nigromaculata Schött, Dicranocentrus meruensis Wahlgr., Pseudachorutes niloticus Wahlgr.) and the rest have so far been found only in Ethiopia (Lepidocyrtinus ethiopicus Den., Seira subdomestica Den. Octoacanthella aethiopica, gen. nov., sp. n.)

The specimens and samples of the litter were taken from four points in southwest and south Ethiopia between 7 and 15 December 1959:

I. 50 km southwest of Jimma in the mountain tropical deciduous forest (altitude about 2000 m),

II. at the bottom of a gorge near a stream in the mountain tropical deciduous forest northwest of Adola (altitude 2400 m),

III. in the Wondo area (same type of forest as that near Adola),

IV. in a mixed coniferous-deciduous forest with Podocarpus gracilior predominating, to the east of Shashamanna (altitude about 2200 m).

From the faunistic lists now available it can be inferred that the species making up the Collembola fauna

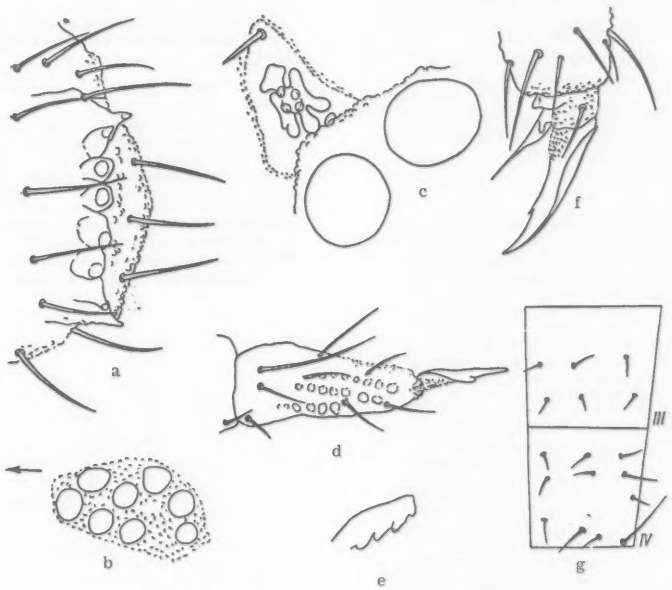


Fig. 1. - Octoacanthella aethiopica, nov. gen., n.sp. a - spines on 6th abdominal tergite; b - ocelli (ocular spot); c - postantennal organ and its two contiguous ocelli; d - furca (dens and mucro), ventral view; e - tenaculum; f - hind leg; g - chetotaxy of 3rd and 4th abdominal tergites (enlargement: a - 20 x 40; b, d - 7 x 90; c, e, f - 20 x 90).

of the mountain regions in East Africa (Ethiopia, Kenya, Uganda, Ruanda Urundi and North Tanganyika) are similar. A whole series of species occur throughout this area: Paronella nigromaculata Schött, Dicranocentrus meruensis Wahlgr., Lepidocyrtinus flaviovirens Börn., Lepidocyrtinus ethiopicus ethiopicus Den., Pseudachorutes niloticus Wahlgr.

On the other hand, a large number of species (about 20) are at present known only from Ethiopia; but until the fauna has been sufficiently studied it would be premature to speak of these as endemic.

A new genus and species — Octoacanthella aethiopica, gen. nov., sp. n., from southwestern Ethiopia is described below, together with 8 other species found in that region. All the material collected in Ethiopia by Shteynberg, including the holotype of the new species, is preserved in the collection of the Institute of Zoology, USSR Academy of Sciences in Leningrad.

Fam. HYPOGASTRURIDAE Börn.

OCTOACANTHELLA Martynova gen. nov.

The majority of its morphological characters place this genus in the family Hypogastruridae Börn. The only important difference is in the number of spines at the extremity of the abdomen. The family is based on the presence of two, more rarely three, spines on the 6th abdominal segment in many species, whereas in Octoacanthella aethiopica there are eight spines, forming a comb along the posterior margin of the segment. It is obvious that additional characters should be introduced into the diagnosis of this family.

The new genus is very similar to the genus Hypogastrura Bourl., from which it differs mainly in the armature (number of spines) of the 6th abdominal segment.

There are eight spines on the posterior margin of the 6th segment (Fig. 1, a) and the furcula is well-developed, with a clearly demarcated mucro. There are eight ocelli on each side of the head (Fig. 1, b). A postantennal organ of approximately the same diameter as an ocellus consists of four large peripheral lobes, four small interior lobes, four small interior lobes and one unpaired additional lobe (Fig. 1, c). There is a simple papilla at the apex of the 4th antennal segment.

Type of the genus, a Octoacanthella aethiopica, sp. n.

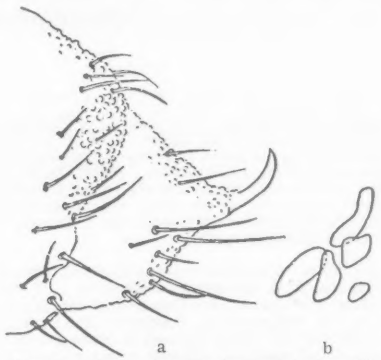
Octoacanthella aethiopica, sp. nov.

Body grayish-violet, with more intensive pigmentation of the head and antennae. Ocular spot dark, almost black. Legs and furcula with diffused violet pigment, weaker on furcula. Granulation of cuticle weak, the granules being very small. Cone-shaped hairs on legs and body lacking. Body length without antennae 1.06 mm, antennae slightly longer than head capsule (12.5: 10.5). Antennal segments (1st, 2nd, 3rd, 4th) in ratio 3:5:6:8. 4th antennal segment apically with an undivided, conical, finely granulated papilla. Postantennal organ equal in diameter to one ocellus, consisting of four peripheral and four interior lobes visible from above in the form of regular rings (Fig. 1, c). There is an additional lobe but this is poorly visible in the mount. Furcula well-developed; manubrium: dens: mucro ratio 52:36:16. Dens with eight chaetae on underside (see Fig. 1, d for the arrangement of these) and three rows of chitinous endplates. Mucro with wide exterior lobe. Branches of tenaculum with four denticles (Fig. 1, e). Claw (Fig. 1, f) long and narrow with one inner denticle, situated at a distance 1/3 the length of the claw from the apex. Empodial appendage with a distinct inner plate and a long terminal seta, reaching the inner denticle of the claw. Cone-shaped hairs lacking on base of leg. The comb consisting of eight spines on the posterior margin of the 6th abdominal segment (Fig. 1, a) sharply distinguishes this species from other representatives of the family. Six inner spines seated in fleshy processes, uniform in size; two lateral spines, slightly longer.

One specimen of this species was found in tropical forest litter in the Jimma district on 7 December 1959.

Ceratophysella denticulata Bagnall, 1941.

Well-differentiated from the nearest related species of the genus by the presence of a section with large granules, slightly elevated above the rest of the surface, on the posterior margin of the tergite of the 5th abdominal segment (Fig. 2, a). The chaetotaxy, structure of the postantennal organ (Fig. 2, b), claw and spines at the extremity of the abdomen fully agree with Gisin's description (1960). Minor differences can be reduced, in the main, to the coloration of the spines, which are of a more intensive yellow in the Ethiopian specimens, whereas



a b

Fig. 2. - Ceratophysella denticulata Bagnall, 1941. a - 5th and 6th abdominal segments; b - postantennal organ (enlargement: a - 20 x 40; b - 20 x 90).

Gisin's description indicates that the pigmentation is weakly developed. Until recently this species was confused with Ceratophysella armata Nic., with the result that there was no definitive clarification of its distribution. It is known to be characteristic of open, warm biotopes and very common in vineyards in southern Switzerland (Gisin, 1955).

One specimen of this species was found in tropical forest undergrowth in the Adola region on 15 December 1959.

Pseudachorutes niloticus Wahlgren 1906.

This species has a number of characteristic morphological peculiarities which make it very easy to distinguish from the species most closely resembling it. The structure of the mandibles, the postantennal organ (6- and 7-lobed) and the furcula fully correspond with Wahlgren's description (1906). The shape of the claw is slightly different in my specimens, perhaps because the drawing in Wahlgren's paper is inaccurate. The claw in P. niloticus from Ethiopia and Uganda (Mabira) (according to Filipchenko's material) is a good deal shorter (Fig. 3).

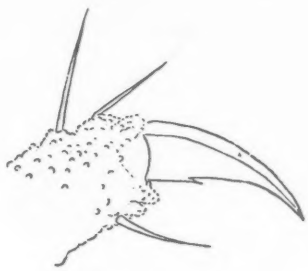


Fig. 3. - Pseudachorutes niloticus Wahlgren, 1906. Hind leg (enlargement 7 x 90).

Found in Ethiopia in tropical forest undergrowth by a stream in the Adola region on 15 December 1959 (2 specimens).

Frisea mirabilis Tullberg, 1871.

Larvae of various instars. The younger individuals (0.4-0.42 mm without antennae) have a weak, diffused blue-violet pigmentation, the ocular fleck is darker and the ocelli are dark, almost black. The larger individuals (0.6 mm) are more strongly pigmented, against a ground which is still as light as before, barely yellowish. Mandible with 7 denticles, 8 ocelli on each side of head, cone-shaped hairs on legs and body lacking. Three spines of uniform structure at extremity of abdomen. Furcula rudimentary, dens thickened, short, with 3 chaetae; mucro hook-shaped.

Tropical forest in the Adola region on 15 December 1959 (5 specimens).

Seira subdomestica Denis, 1924.

There is no doubt that our specimen belongs to this species. Very little need be added to the diagnoses by Denis (1924) and Salmon (1954a, b), based on material from Ethiopia and East Africa. Seira subdomestica is characterized by its light, whitish-yellow coloration; only the ocular fleck and the unpaired frontal ocellus are dark (violet-black). Antennae 2.5 times as long as head capsule, violet, with darker 3rd and 4th segments. Ratio of antennal segments 37:47:47:73 (left antenna); the right antenna is abnormal, with undivided 3rd and 4th segments.

The shape and structure of the claw and empodial appendage are as in the drawing by Denis (1924). Furcula slightly longer than half the body (55:32).

Ethiopia, tropical forest southeast of Wondo, undergrowth, 13 December 1959 (1 specimen).

Lepidocyrtus cyaneus Tullberg, 1871. f. pallida Reut.

In coloration, structure of claw and empodial appendage and other characters the specimen is indistinguishable from European specimens. Furcula and legs unpigmented, a diffused bluish pigment on body and head, antennae bluish-violet.

Tropical forest southeast of Wondo, 13 December 1959 (1 specimen).

Lepidocyrtinus ethiopicus Denis, 1924 (Sira ethiopica Denis, 1924)

Most of the characters in our specimens agree with the descriptions of Lepidocyrtinus ethiopicus Den. from Ethiopia (Denis, 1924) and Uganda (Salmon, 1954 c, d). We shall therefore merely give a brief description of this species, dealing in greater detail with features not mentioned by these two authors.

> Size 4.2 mm. Coloration yellowish, varying in intensity, with dark violet, almost black ocular spots and a transverse band joining them. Coloration of antennae variable, 3rd and 4th segments being violet in almost all the specimens, with a more intensive coloration at the base of the segment. First and 2nd segments with traces of a diffuse violet pigment, more often at the base of the segment than elsewhere; 3rd and 4th segments articulated. Length of antennae slightly variable and 3 to 4 times that of the head capsule. Ratio of antennal segments 5:6:9:4. Specimens with undivided 3rd and 4th segments are often found.

The species is very simple to L. annulipes Handsch. in the coloration of the legs, which is highly characteristic (Handschin, 1929). On the 2nd pair of legs there is invariably a dark patch on the distal part of the femur and on the 3rd pair of legs there is a similar patch on the distal part of the femur and on the trochanter. In individuals of more intensively developed pigmentation the entire surface of the trochanter, as well as the proximal part of the femur, is violet. These patches stand out very sharply against the light yellowish background. The first pair of legs may have traces of violet pigment in the proximal part but these are often lacking.

The structure of the claw and the empodial appendage is exactly as shown in the Salmon drawing (1954a): claw with a pair of large internal proximal teeth and 2 smaller distal teeth; 1 central and 2 lateral teeth externally; empodial appendage with dentate external margin, six or seven tenths longer than the claw.

Body covered with scales and chaetae; body; as far as the base of the claw, head, first 3 antennal segments and furcula also covered with scales.

Manubrium:dens:mucro in ratio 46:65:5 or 38:55:2.

L. ethiopicus Den. was found in forest undergrowth east of Shashamänna on 15 December 1959 (1 specimen) and in the Wondo region (3 specimens) on 13 December 1959.

Dicranocentrus meruensis Wahlgren, 1908

Two species of Collembola referred to the genus Dicranocentrus Schött have been found in Ethiopia, mainly in the central part: D. aethiopicus Handsch. and D. stachi Den. The latter was found again in Ethiopia by Handschin in 1929. It was redescribed by Salmon (1954a) from specimens from the nearby regions of Ruwenzori and Uganda. In the Denis and Salmon descriptions there are no indications of spines at the base of the dens; Salmon, indeed, specifically indicates that the dens is covered with scales, but not with spines. The descriptions of both authors seem to refer to one and the same species, in which the absence of spines on the dens and the presence of 3 denticles (a double proximal and 2 distal) and of a lanceolate empodium with 1 external denticle are characteristic. Handschin, in a short description of D. stachi from Ethiopia, says that in his specimens the presence of a large number of spines at the base of the dens is a characteristic feature, which he believes Denis simply failed to notice; as regards other characters his diagnosis differs hardly at all from that of Denis. The spines on the dens, however, are visible in any position of the furcula and it is impossible to miss them. The specimens at Handschin's disposal must obviously belong to another species of the genus, resembling D. stachi Den. in the coloration and structure of the claw and empodial appendage.

Shteynberg's Ethiopian collections contain 13 specimens belonging to the genus Dicranocentrus and resembling D. meruensis Wahlgr. in a number of characters but also resembling specimens which Handschin identifies as D. stachi. All have distinct spines on the dens, which exclude affinity to D. stachi Den.

Handschin's specimens and those at my disposal seem to belong to the same species, taxonomically very close to D. meruensis Wahlgr. but differing from it in the presence of a small external denticle on the empodial appendage. In Wahlgren's description (1908) there is no indication of this character, which he probably did not notice.

As it is impossible to compare the available material with Wahlgren's type there is little sense in identifying these specimens as an independent species on the basis of a single character, especially as they do not differ from the Wahlgren type in any other characters.

The following is a short description of the Ethiopian Dicranocentrus, which I identify as Dicranocentrus meruensis Wahlgr.

> Size 3.4-4.6 mm without antennae. Body yellowish, densely covered with brownish scales of circular shape, larger at the boundaries of the segments. Scales also thickly cover the head, the 2nd, 3rd and 4th antennal segments and the legs, right down to the claw. There is an admixture of diffused violet pigment with the basic yellowish background in the anterior part of the head, the sides the sternum and the legs. The furcula is light yellow. Eight ocelli on each side of the head; ocular spot black. Antennae secondarily 6-segmented, 2.0-2.6 mm long; the 2 last antennal segments (5th and 6th) articulated. Antennal ratios (I: II:III:IV:V:VI) 17:85:20:92:135:142.

The relative length of the individual segments

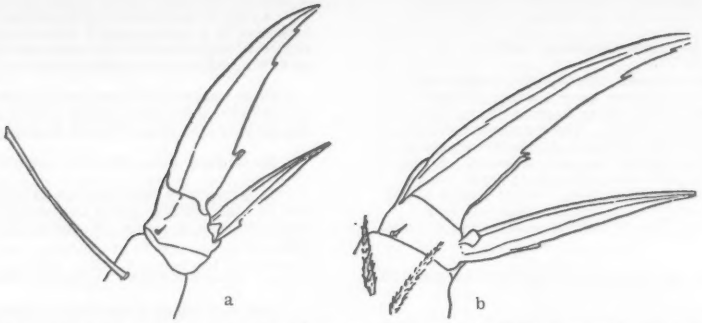


Fig. 4. - Dicranocentrus meruensis Wahlgren, 1908, specimen from Jimma region. a - fore leg; b - hind leg (enlargement 20 x 40).

varies slightly, particularly as regards the last two. Specimens with abnormal antennae, with undivided 5th and 6th segments, are very common, the 6th segment invariably being shorter than the 5th and 6th segments combined in antennae of normal structure. Specimens with 3-segmented antennae are occasionally found. The coloration of the antennae is typical in this species: the first 4 segments are light yellow, with sharp, broad, dark violet rings in the distal part of the 2nd and 4th segments and the 5th and 6th segments are violet.

Claw with a double proximal and 1 unpaired distal denticle; empodial appendage narrow, lanceolate, with small external denticle near the base. In the first pair of legs the empodial appendage does not reach the distal denticle but in the 3rd pair it is appreciably longer and does reach the distal denticle.

The specimens from the Jimma region differ considerably from this typical form. They have a larger amount of pigment on the body, head, terminalia and antennae, so that in individual specimens the basic light yellow background almost disappears. The legs are violet, except for the distal part of the tibiotarsus. The antennae are violet throughout, without characteristic dark bands on the 2nd and 4th segments. As in the typical form the antennae often have undivided 5th and 6th segments. Apart from the color, there are other differences: the claw has an extra denticle in the distal part, near its apex (Fig. 4) on all legs, which is not found in any specimen of Dicranocentrus meruensis from other regions. The shape and length ratio of claw and empodial appendage are the same as in the typical form. The furcula is light yellow, without violet pigment. D. meruensis from Kenya (Molo), (Dogel and Sokolov collections, 1916, identified by Filipchenko, 1926) has a coloration characteristic of the specimens from Jimma but without the additional distal denticle. Both these features (coloration and number of denticles on the claw) are variable.

The material representing these species was collected at several points in the southwest and south of Ethiopia: 1) a forest in the Shashamanna region, 15 December 1959, 7 specimens; 2) a tropical forest in the Wondo region, 13 December 1959, 27 specimens; 3) a tropical forest in the Jimma region, 7 December 1959, 4 specimens.

Paronella nigromaculata Schött, 1903.

From a series of descriptions (Wahlgren, 1908; Filipchenko, 1926; Handschin, 1929; Salmon, 1956) it appears that this species varies greatly as regards color and also in certain morphological characters. Salmon (1956) lays special emphasis on this, pointing out that the coloration of P. nigromaculata from Ruanda Urundi varies a good deal, from pale yellow to dark brownish with bluish or violet pigment on the antennae, head, legs and body, although this pigment may sometimes be lacking. At the same time, the arrangement of the ocelli and the shape of the denticles on the mucro vary appreciably and there is sometimes an additional denticle on the ventral side of the mucro. Salmon's contention that this species is highly variable is corroborated by examination of our Ethiopian material; so too is Filipchenko's statement that Paronella fuelleborni C. B. is a synonym for Paronella nigromaculata Schött. Individual specimens from Shteynberg's collections combine the characters of both species.

There is no need to repeat here the very full description of P. nigromaculata published by Salmon in 1956 and supported with a large number of drawings. I shall therefore restrict myself to a brief description, dwelling in greater detail on characters not mentioned by Salmon or present only in the specimens at our disposal.

The coloration varies greatly from straw-yellow to brownish, with a very slight admixture of diffused bluish or violet pigment on the ventrolateral surface of the thoracic and abdominal segments in most specimens; there is also a violet pigment on the coxae, head, antennae and, more rarely, the proximal part of the femur and trochanter. On the antennae the 3rd and 4th segments always have a bluish or violet color while the 1st and 2nd segments are yellow, with a very slight admixture of violet in some specimens. In two specimens all the antennal segments are violet.

In most individuals the legs are light yellow, the proximal part of the femur and the tibiotarsus sometimes being slightly violet. The furcula is light yellow, and there is occasionally a violet pigmentation at the base of the manubrium. In the Jimma specimens the violet pigment is exceedingly strongly developed. The yellowish coloration of the body is retained only on the dorsal surface of the thorax and first 3 abdominal segments; but it is retained also on the legs and furcula.

The antennae are 2/3 the length of the body. Ratio of segments (I:II:III:IV) 8:12:10:17 or 12:17:15:26. Fourth antennal segment articulated, but individuals with undivided 3rd and 4th antennal segments do occur.

The claw structure deserves special attention. The form of the claw and the empodial appendage and the relative length of the legs coincide with the existing descriptions, but the length ratio of claw and empodial appendage is not constant. In most specimens the empodial appendage on the 1st pair of legs reaches only the proximal denticle of the claw; on the 3rd pair of legs it reaches the distal denticle. Much more rarely the empodial appendage is shorter, not reaching the proximal (1st leg) and distal (3rd leg) denticles (Fig. 5a, b). In all specimens in our material there is an extra distal denticle at the very apex of the claw.

Fig. 5. - Paronella nigromaculata Schött, 1903, from Wondo region. a - fore leg; b - hind leg; c - mucro (enlargement 20 x 40).

Fig. 6. - Paronella nigromaculata Schött, 1903, from Molo (Dogel and Sokolov collections, 1916). a - hind leg; b - mucro (enlargement 20 x 40).

In the Kenyan specimens (Dogel and Sokolov collections), the 2nd distal denticle is lacking (Fig. 6a). In 1903 Börner described a new species, Paronella fuelleborni C. B., from specimens in which the violet pigment was strongly developed and which had an additional denticle on the claw. As both these characters – the coloration and the number of claw denticles – vary greatly (in our individuals the extra denticle was present also in the light-colored individuals) P. fuelleborni must be regarded merely as the melanistic form of P. nigromaculata Schött. Salmon characterizes P. nigromaculata as an extremely varying species. This view is borne out by data on the variability of color, claw armature and considerable differences in the form of the mucro. The most typical form of mucro is that with 4 denticles (Schött, Wahlgren, Handschin, Salmon; Fig. 7c), although even in this case the form of the apical and preapical denticles differs slightly from one individual to another. In some of the Ruanda Urundi specimens (Salmon, 1956) there is a small additional denticle (Fig. 7b). In our Ethiopian specimens, on the other hand, and in P. nigromaculata from Kenya[1] there are only 3 denticles, for the basal denticle on the ventral side of the mucro is always lacking (Fig. 5c and 6b). The apical and preapical denticles can be either acuminate or retuse (Figs. 5c, 6b and 7a).

All the specimens at our disposal have two rows of spines on the dens, one on the exterior and one on the interior. This character was first noticed by Salmon; the other authors do not mention it.

Found in undergrowth in a tropical forest southeast of Wondo on 12 December 1959 (10 specimens) and in the

[1] Filipchenko (1926) was mistaken in indicating the presence of 4 denticles on the mucro in his B. nigromaculata specimens. This was discovered when his mounts were examined.

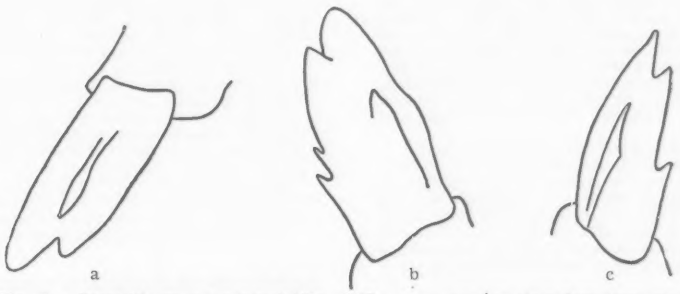


Fig. 7. - Paronella nigromaculata Schött, 1903. a - mucro (specimen from Jimma region); b - mucro (specimen from Ruanda Urundi, after Salmon, 1956); c - mucro (specimen from Addis Ababa region, after Handschin, 1929).

Jimma region on 7 December 1959 (1 specimen).

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THE TAXONOMIC POSITION AND GEOLOGICAL AGE OF MAYFLIES OF THE GENUS EPHEMEROPSIS EICHWALD (EPHEMEROPTERA, HEXAGENITIDAE)

O. A. CHERNOVA

In 1959 members of the paleoentomology laboratory of the Institute of Paleontology (USSR Academy of Sciences) collected numerous mayfly fossils from Mesozoic deposits on the left bank of the river Vitim, 9 km below the mouth of the river Baysa (Transbaykaliya). This material was passed over to me for study.

A good many winged forms (4 families, several genera) have so far been described, from Paleozoic mayflies, but comparatively few of the nymphs have been found. The situation as regards Mesozoic mayflies is different. Ephemeropsis nymphs from the Transbaykalian Mesozoic were found a century ago (Eichwald, 1864) and have since been repeatedly found in many other locations in eastern Asia. The deposits usually contain large quantities of these fossils, often so many as to form layer upon layer. These rarely include remains of the winged stages of these mayflies, which occur only as fragments; not a single entire fore or hind wing had been found. For this reason it has so far been difficult to draw any definite conclusions about the taxonomic position of these insects.

The material submitted to me for study contains wings in an excellent state of preservation, with the venation almost as clear as in a modern specimen. Several entire hind and fore wings were found (unfortunately, most of the entire fore wings have turned out to be folded together and are therefore difficult to examine) and one almost completely preserved specimen of an imago, lying in profile.[1]

In this paper only the imaginal stage will be discussed. The nymphs of Ephemeropsis are being studied by Meshkova and will be described separately. As they are in a better state of preservation than those previously described, the false conclusions and erroneous reconstruction given in Demoulin's work (1956) can be corrected.

Several wing fragments, the sole findings of winged Mesozoic mayflies, are known from Mesozoic deposits in western Europe (south Germany). Practically all we have, therefore, is single nymphs from the east Asian Mesozoic and mayfly wings from the European Mesozoic. Part of these findings in western Europe are represented by homonomously winged mayflies which can be classified as belonging to the family Mesephemeridae and which I refer, along with the Permian homonomously winged mayflies, to the suborder Permoplectoptera (Tillyard, 1932; Chernova, 1961). Other fossils are mayflies with heteronomous wings, belonging to 2 genera, Paedephemera Handlirsch, 1908 and Hexagenites Scudder, 1880. These are the first fossil mayflies in which the second pair of wings is reduced in size and is roughly 2/3 the length of the fore wings. They are nearer to the modern than to the homonomously winged mayflies and I refer them, along with modern Ephemeroptera, to the suborder Euplectoptera Tillyard 1932. The types of these Paedephemera Handlirsch and Hexagenites Scudder species described long ago were examed by F. Carpenter (1932) and Demoulin (1953 a, 1953 b, 1954, 1955 a, 1955 b, 1956 and 1958). Demoulin, in his paper on the revision of the family Paedephemeridae (1955 b) and in his taxonomy of the suborder (1958), placed both these genera in one family, Paedephemeridae Laméere, along with the two modern oriental genera Chromarcys Navàs and Pseudoligoneuria Ulmer; these two genera are little known and their taxonomy is unclear. This is not the place to discuss Demoulin's taxonomy as a whole, but in regard to the Mesozoic mayflies it should be noted that the genus Paedephemera differs substantially from Hexagenites; the former taxonomy should therefore be restored and these two genera should be placed in different families, Paedephemeridae and Hexagenitidae respectively, as Demoulin did in his earlier work (1954). My somewhat modified descriptions of these two families are given below.

Family PAEDEPHEMERIDAE Laméere, 1917

(Synonym: Stenodicranidae Demoulin, 1954)

Posterior margin of fore wing and wing tip rounded: transverse veins on fore wing set fairly well apart and not forming a dense network (they are not present at all on the hind wing); no gemination of veins. CuA_1 of fore wings has no distinct division. Nymphs unknown. One genus.

Genus PAEDEPHEMERA Handlirsch, 1908

Type of the genus: Ephemera multinervosa Oppenheim, 1888; Upper Jurassic, western Europe (Malm, Solenhofen).

Intermediate veins of cubital area straight, parallel, running from CuA_1 to posterior margin of wing. Length of fore wing 22 mm, of hind wing 14 mm. Two species — P. multinervosa Oppenh. and P. schwertschlageri Handl. Upper Jurassic, western Europe.

Family HEXAGENITIDAE Laméere, 1917

Nom. transl. Demoulin, 1954 (ex Hexagenitinae Laméere, 1917).

(Synonym: Ephemeropsidae Cockerell, 1927.)

Fore wing triangular, its posterior margin with a well-defined tornus, transverse veins in anterior and posterior wings dense; gemination of longitudinal veins present. CuA on fore wing divided, a branch running from the bifurcation and producing a series of regular loop-shaped further bifurcations. Nymphs (in Ephemeropsis) with 7 pairs of single leaf-like gills situated on the sides of the abdomen; sides of abdominal segments with recurrent processes. Caudal filaments thickly covered with long hairs. Two genera. Jurassic.

Paedephemeridae and Hexagenitidae must therefore be regarded as two independent families. The Paedephenemera material is unquestionably less well preserved than the Ephemeropsis or even the Hexagenites material and it is therefore difficult to discuss the character of its venation and its connections with other families; but it should be emphasized that in all these three Mesozoic genera heteronomous development of the wings appears for the first time.

As we see, the venation in Ephemeropsis is unusually rich. The Permean mayflies, Protereismatidae and others, have a much poorer network of veins. The reason for the

[1] I take this opportunity of thanking those who collected this interesting material — the leader of the expedition, O. M. Martynova and staff members N. P. Meshkova and A. G. Ponomarenko.

dense network in Ephemeropsis is that with the reduction of the hind wing the fore wing enlarges and acquires a triangular shape; as its surface increases it requires greater strengthening. The last point is particularly important, for the Ephemeropsis were very large insects with sturdy bodies. Moreover, in Hexagenitidae gemination of the longitudinal veins had developed – that is, approximation of two neighboring veins at the posterior margin of the wing. Division or gemination of the veins also strengthens the wing plate; in this way, a concave and a convex vein, approximate to each other, appear and by their very presence form sharp folds or a strong corrugation.

I must say a word on the last taxonomic classification of the order proposed by Demoulin (1958). This is based partly on the modern fauna but also partly on paleontological material. The family Paedephemeridae, along with Isonychiidae, Baëtiscidae and Oligoneuriidae, make up the superfamily Oligoneurioidea, founded by Demoulin.

According to Demoulin the family Paedephemeridae is made up as follows: Chromarcys Navás, 1932 and Pseudoligoneuria Ulmer, 1935 as the modern representatives (Eastern Province), and Ephemeropsis Eichwald, 1864, Hexagenites Scudder, 1880 and Paedephemera Handlirsch, 1908 as the Mesozoic. The family thus contains 5 genera in all. Demoulin's argument for referring Hexagenites to the modern Oligoneuriidae is based on the presence of vein gemination which, it should be noted, is not so well marked in Hexagenites, whereas the venation of Ephemeropsis was almost unknown to Demoulin. It is therefore impossible to agree with him that the Hexagenitidae are affiliated with the Oligoneuriidae, especially since the complete venation of Ephemeropsis has become known. Demoulin mentions two types of longitudinal vein gemination, "Palingeniidic" and "oligoneuriidic" (Demoulin, 1954: 557). In the former the approximation of the principal to the intermediate trunks is produced pair by pair and, consequently, in the posterior half of the wing; in the second type the approximation of the veins starts from the wing base and, in the absence of intermediate veins, only the principal longitudinal veins are approximated; this type of wing gemination Demoulin for some reason regards as archaic. It should be said that the wing gemination in Hexagenitidae is clearly of Palingeniidic type.

The Oligoneuriidae are an extremely specialized group, in which, apart from a whole series of specialized features in the structure of the imago, the wings have reduced venation – intermediate longitudinal veins are lacking and the transverse veins are reduced. We therefore see no reason to associate the Mesozoic mayflies with the Oligoneuriidae. The general impression of the Hexagenitidae wing venation rather indicates that they should be aligned with Palingeniidae; these, like other mayflies, are large insects with richly developed venation and an identical type of vein gemination, with branching CuA. The distribution of representatives indicates, too, that this family is with few exceptions distributed in the New World and in the African province, whereas Palingeniidae are widely distributed in the eastern and palearctic provinces (Chernova, 1958: 67, 68). Demoulin (1953 b: 7) suggests that the Jurassic Hexagenites have remained almost unchanged to this day and are represented by the modern genera Chromarcys and Pseudoligoneuria, and that these two genera are residues of Oligoneuriidae which fluorished in earlier geological times, before they settled in Europe. All these assumptions of Demoulin's are without foundation; the theory that Chromarcys and Pseudoligoneuria are related to the Mesozoic mayflies is wrong.

The family Hexagenitidae should be regarded as made up of two genera, Hexagenites Scudder and Ephemeropsis Eichwald.

Genus HEXAGENITES Scudder, 1880

(Synonym: Paedephemera Handlirsch, 1908, p. p.)

Type of the genus: H. weyenbergi Scudder, 1880; Upper Jurassic, Western Europe (Malm, Solenhofen).

Medium-sized insects. Wing venation moderately developed. Fore wing triangular; terminal margin of wing much longer than anal; this indicates that the hind wing in Hexagenites must have been even smaller as compared with the fore wing than in Ephemeropsis; longitudinal

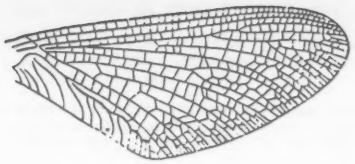

Fig. 1. – Hexagenites weyenbergi Scudder. Fore wing. After Carpenter.

veins in apical half only very slightly curved, particularly the CuA_1, which is almost straight; in the first cubital area there are 4 loop-shaped bifurcations, each with an oblique vein. Transverse veins in cubital and anal areas not developed (this part of the wing has possibly been poorly preserved). Gemination of veins only in radial sector and in first medial veins. Hind wing unknown.

Composition of the genus; 2 species, Upper Jurassic, western Europe (south Germany, Solenhofen). First species; H. weyenbergi Scudder, 1880 (synonym: Paedephemera oppenheimi Handlirsch, 1908).

One well-preserved fore wing is known (Fig. 1). Length – 16 mm.

In the second species, H. mortua (Hagen, 1862), the length of the fore wing is 19 mm. In addition, Demoulin (1955 b: 6) indicates remains of forceps consisting of 7 segments.

Genus EPHEMEROPSIS Eichwald, 1865

(Synonym: Phacelobranchus Handlirsch, 1908).

Type of genus: E. trisetalis Eichwald, 1884: Upper Jurassic, Transbaykaliya (Turganian stage, Tovego).

Very large mayflies. Wing venation rich. Fore wing triangular; anal margin of wing barely longer than terminal; longitudinal veins very strongly curved apically, particularly CuA_1; in the first cubital area there are 3 loop-shaped forks, with an oblique vein inside each. Transverse veins very numerous throughout wing. Gemination of veins of fore and hind wing very marked. Hind wing with richly developed venation. Two species. Upper Jurassic of Transbaykaliya, Mongolia and north China.

The important similarity of these two genera as regards wing venation needs stressing. The extremely characteristic forking of CuA and the regular three-fold loops in it, with an oblique vein within each of them, are the most striking features when one examines the Ephemeropsis fore wing. In this genus the CuA loops are very distinct and the veins demarcating them are strangely curved. The Hexagenites wings undoubtedly had similar CuA loops but the Ephemeropsis wing venation up to now has not been known precisely and the CuA system in Hexagenites has been incorrectly treated by Demoulin (1953b) as bearing a resemblance to that of Pseudoligoneuria.

The structure of the CuA system was undoubtedly very similar in the Mesozoic Hexagenites and Ephemeropsis and is not found in any modern mayflies. It is this peculiarity of the CuA, along with the whole type of the venation and the character of the wing gemination, as well as the shape of the wing that convinces me of the relationship between these two Mesozoic genera, which refer to a single family, the Hexagenitidae.

Ephemeropsis trisetalis Eichwald, 1864

(Synonyms: Ephemeropsis orientalis Eichwald, 1868; Phacelobranchus brauеri Handlirsch, 1906; Ephemeropsis middendorfi Handlirsch, 1906; Ephemeropsis melanurus Cockerell, 1924; Handlirsch, 1939).

Female imago. Compound eyes large, oval and situated

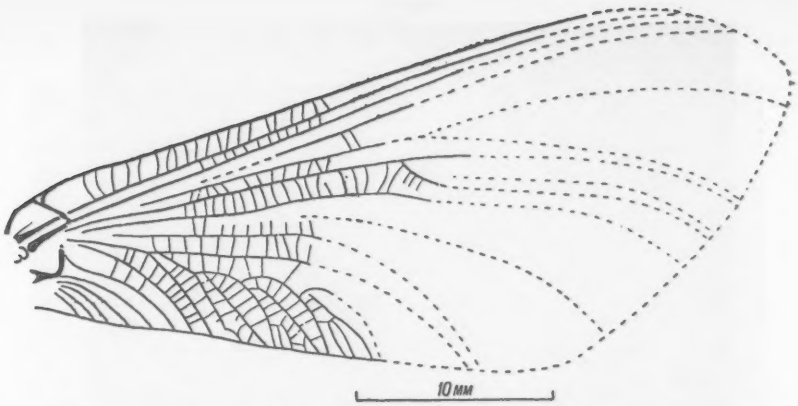

Fig. 2. - Ephemeropsis trisetalis Eichwald. Fore wing. PIN coll. No. 1008/71. Baysa. Upper Jurassic.

on the sides of the head. Prothorax small. Fore femur short and fairly slender, slightly thickened medially. Wings large; hind wing a good deal more than half as long as the fore wing (about 0.58 of its length). Fore wing (Fig. 2) with loop-shaped forks of Cu in cubital area, these loops being short and wide (2-2.5 times as long as they are wide) CuP joined to CuA_2 and to anal vein by distinct transverse veins. Hind wing (Plate II, Fig. 1; Fig. 3) with apex rather elongate gemination of veins very distinct; intermediate veins in cubital area comparatively short. Abdomen fairly sturdy, tapering slightly (Plate I, Fig. 1). Two long caudal filaments (cerci) and a short paracercus (Fig. 4). Ovipositor in the form of a protuberant plate on 7th sternite (Fig. 5).

Male imago. Only the end of the abdomen has been found. This bears cerci and segmented forceps, with a rounded plate protruding between legs of forceps; protruding paired penis lacking (Fig. 6).

Size. Body length of female imago without last abdominal segment — 47 mm; over-all body length about 49 mm; length of fore wing 41-42 mm, width at point where media forks 14.5-16 mm, at point where cubitus forks 9.5-10 mm; length of hind wing 24 mm, its width at point where media forks 13-14.5 mm.

Material from the collection of the Institute of Paleontology (AN SSSR). Baysa (Transbaykaliya), Vitim r. 9 km below mouth of Baysa r. Upper Jurassic, Turganian-Vitimian bed; complete insect: No. 1668/216; end of abdomen with caudal filaments No. 1668/98; fore wing: No. 1008/171 (not complete wing), 1668/8 (two fore wings with poorly preserved venation), 1668/44 (incomplete fore and hind wings), 1668/47 (wing base), 1668/48 (part of fore and poorly preserved hind wing), 1668/57 (wing base), 1668/142 (anterior margin and anal part of wing) 1668/152 (basal half of wings), 1668/227 (entire wing); hind wings: 1668/7 (apical part), 1668/11 (base of wing), 1668/52 (entire wing), 1668/99 (entire wing).

Anda-Khuduk (Ondai-Sair), Mongolian Peoples' Republic, Mt. Ushyug, 9 August 1948, No. 467/90 (end of male abdomen with genital forceps).

All the Ephemeropsis species previously described were established from the nymphs, without adequate foundation; I regard them as synonyms of one species, for which I have retained the old name Ephemeropsis trisetalis

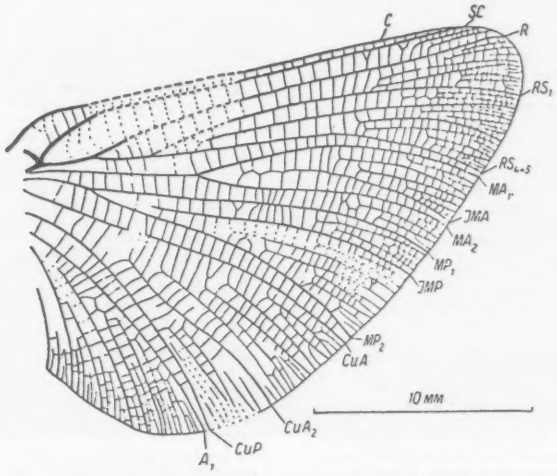

Fig. 3. - Ephemeropsis trisetalis Eichwald. Hind wing. Coll. PIN No. 1668/52. Baysa. Upper Jurassic.

Plate 1

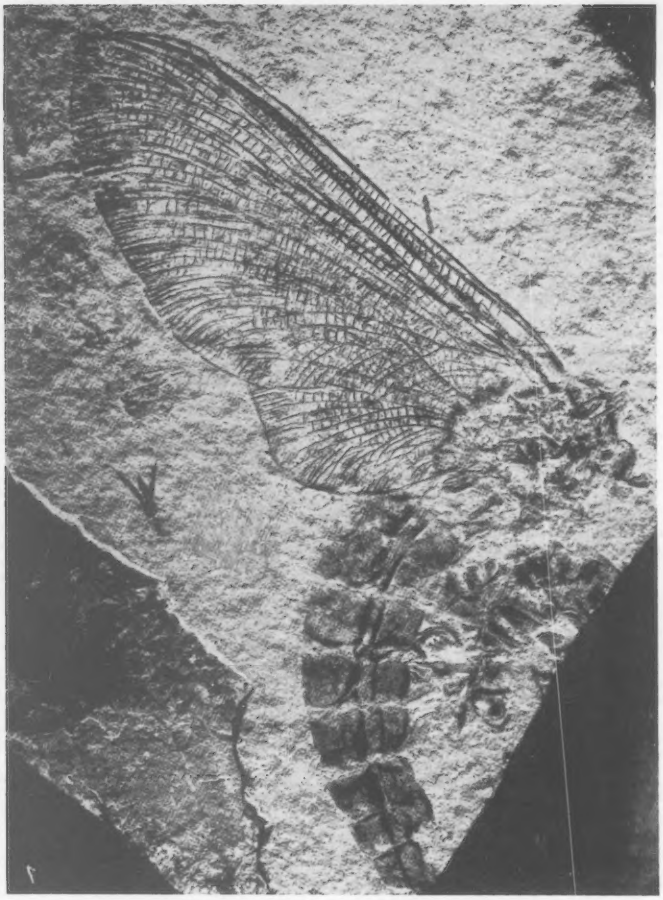

Fig. 1. - Ephemeropsis trisetalis Eichwald, Coll. PIN No. 1668/216. Baysa. Transbaykaliya. R. Vitim 9 km below mouth of Baysa. Upper Jurassic.

Eichwald, 1864. A second species has been found among the remains of the winged insects and any of the old names suggested previously could be adopted for this species, so as to avoid multiplying names purely formally. It must, however, be said that earlier authors regarded the structure of the gill lamina as the basic character for establishing the species; but Meshkova's study (1961) which threw light on the real structure of the Ephemeropsis gill lamina, showed that these were poorly preserved in the material at the earlier authors' disposal. The gill structure is obviously of no use for distinguishing winged insect species. Another character used to distinguish species from the nymphs was the body size, but this too cannot be used as a true criterion since mayfly nymphs have many ecdyses. All this obliges me to describe the second Ephemeropsis species as a new species, for which I have suggested a special name.

The most recent data on Ephemeropsis structure are Cockerell's, based on wing fossils from Mongolia. In his first paper (1924) Cockerell gave a drawing of the basal part of the Ephemeropsis trisetalis Eichw. fore wing (Fig. 3), and in addition a small part of a wing, without the veins marked (Fig. 4). Martynov (1931) suggested that Cockerell's Fig. 4 represented part of the hind wing. Now that we actually have complete hind wings it has become obvious that Cockerell was illustrating the cubital region of the hind wing and Demoulin's suggested reconstruction of the Ephemeropsis fore wing, based on Cockerell's work, must be definitively rejected; it was in fact based on the basal part of the fore wing together with the cubital region of the hind wing.

In a later paper Cockerell (1927), dealing with a small amount of additional Ephemeropsis fossil wing material from Mongolia, discussed the origin of the cubital branching and rightly pointed to the similarity with modern Palingeniidae as regards this part of the wing venation. In the same paper he established two varieties for the species Ephemeropsis trisetalis Eichw.: E. trisetalis berkeyi, on the basis of the previously described material, now known to be the remains of a hind wing, and E. trisetalis chaneyi, on the basis of a fore wing in which the beginning of the CuA branching has been preserved. Both these forms are undoubtedly valid.

Ephemeropsis martynovae O. Chernova, sp. nova.

Imago. Fore wing preserved almost in its entirety (Fig. 7). Vein gemination strongly developed; media curved in its apical third and approximate to the last branch of the radial sector; posterior branch of media (MA_2) runs almost at a right angle from MA_1 and approaches the intermediate MA vein; apart from this intercalated vein in the fork of media there are two further intermediate veins; the MP vein occupies a large region of

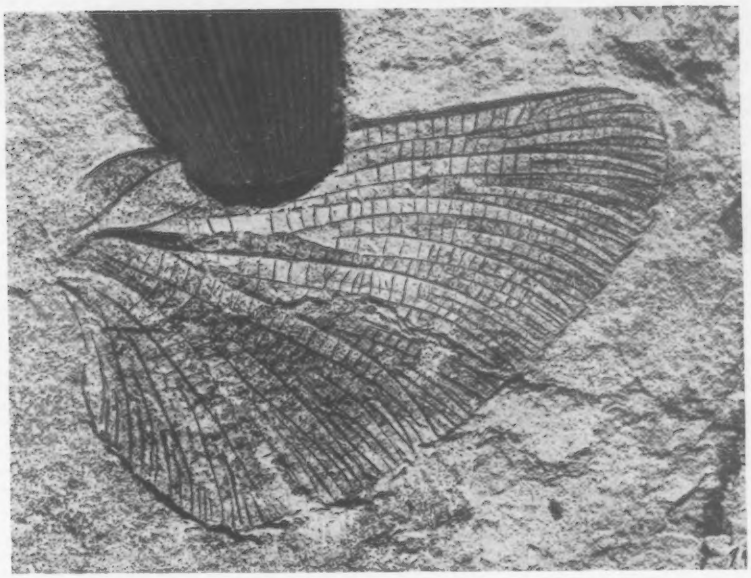

Fig. 1. - Ephemeropsis trisetalis Eichwald. Hind wing. Coll. PIN No. 1668/52. Baysa. Transbaykaliya, r. Vitim, 9 km below mouth of Baysa. Upper Jurassic.

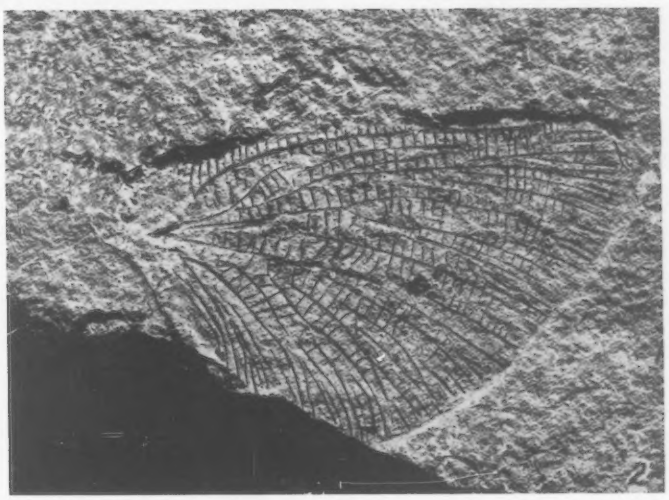

Fig. 2. - Ephemeropsis martynovae Chernova, sp.n. Hind wing. Coll. PIN No. 1668/862. Baysa. Transbaykaliya, r. Vitim, 9 km below mouth of r. Baysa. Upper Jurassic.

(Photographs by A.V. Skinder, taken in the photographic laboratory of the Institute of Paleontology, AN SSSR.

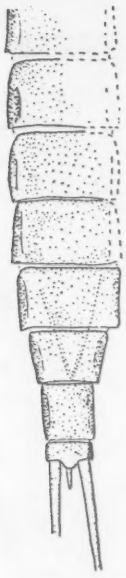

Fig. 4. - Ephemeropsis trisetalis Eichwald. Abdomen of female imago with two caudal filaments and short paracercus. PIN coll. No. 1668/98. Baysa. Upper Jurassic.

the wing; its five branches spread fan-wise and there are two fairly long intermediate veins between them; the last MP_2 branch is approximate to the CuA_1; in the fork of the CuA there are three loop-shaped, long, narrow forks, three times as long as they are wide; the CuP and the anal veins are connected by distinct transverse veins. The hind wing (Fig. 8; Plate II, Fig. 2) differs from that of E. trisetalis in having a rounded apex; all the venation is similar to that of the preceding species except that the intermediate veins in the cubital area are longer and the CuA_1 itself is more curved.

Size: length of fore wing 35 mm, width at point where media forks 15 mm, width at point where cubitus forks 8.5 mm; length of hind wing 17 mm; width at point where media forks 11-12 mm.

Material from the Institute of Paleontology collection. Holotype No. 1668/846; Baysa, negative imprint of left fore wing.

Location: Transbaykaliya, Vitim r. 9 km below mouth of the Baysa r. Apart from the holotype there are two hind wings, No. 1668/862 and 1668/85.[2]

As can be seen from the sizes mentioned this species is appreciably smaller than E. trisetalis Eichw. It should be mentioned that females of the modern mayflies are invariably larger than the males. The length of the fore wing in Palingenia longicauda Oliv. (♂) for example, is 24-30 mm and (♀) 28-38 mm; in Heptagenia flava Rost. the length of the fore wing is 10-12 mm in the male and 11-15 mm in the female; in Isonychia ignota Walk. it is 12 mm in the male and 13 in the female. The differences in wing size in the Mesozoic mayflies (35 against 42 mm in the fore wings and 17 against 24 mm in the hind wings) correspond to variations in the size of the wings in both sexes of modern mayflies. It is nevertheless difficult to regard the whole series of wing venation characteristics described above as due to individual variation and I have therefore been obliged to distinguish a second Ephemeropsis species, which I have named for the paleoentomologist O. M. Martynova.

On the geological age of the fauna complex containing Ephemeropsis mayflies opinions vary. The late nineteenth century authors (Brauer, Redtenbacher, Ganglbauer, 1889) and Handlirsch (1906), without special proof, considered this fauna as Jurassic. Cockerell (1924, 1927) mentions the Lower Cretaceous age for the Ephemeropsis mayflies, on the basis of material from Mongolia (Ondai-Sair). Ping (1928) and Ueno (1935) support this view in relation to the Jehol beds in north China. Martynov (1931) was inclined to refer Ephemeropsis from the Nalaykhian strata (Mongolia) to the Upper Jurassic.

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[2]Hind wing small, half the length of the fore wing. This wing apparently belongs to an individual of the other sex or to a very small specimen. The imprint of the hind wing was found separately and is not connected with the remains of fore wings.

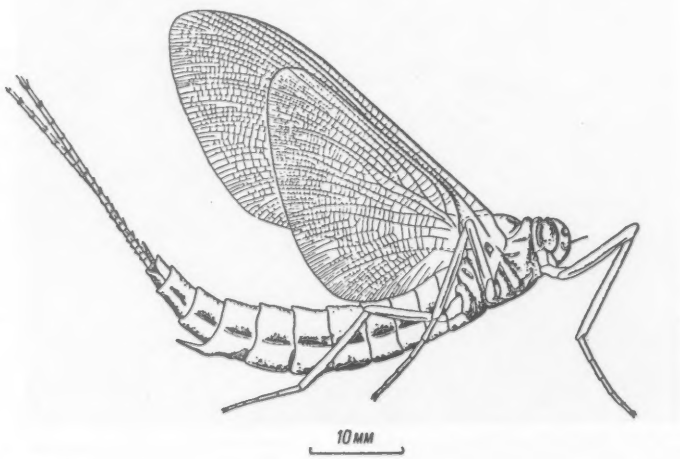

Fig. 5. - Ephemeropsis trisetalis Eichwald. General view of female imago. Reconstruction, based mainly on examination of specimens No. 1668/216 and No. 1668/52.

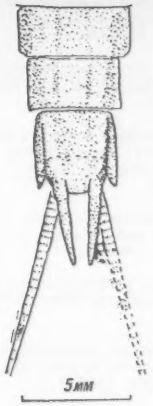

Fig. 6. - Ephemeropsis trisetalis Eichwald. End of male abdomen. Mongolia, Andakhuduk Coll. PIN No. 467/90. Upper Jurassic.

In recent times G. G. Martinson has worked on the geology and fauna of the Transbaykaliyan Mesozoic and his conclusions deserve more detailed consideration. He believes that all the Mesozoic continental deposits in Transbaykaliya may be taken as belonging to a single age. B. A. Ivanov believing them to be Lower Cretaceous and V. A. Obruchev believing them to be Jurassic (Martinson 1955 b: 82). Martinson, after studying the molluscs, showed that in Transbaykaliya the Mesozoic continental strata were formed over a fairly long period of geological time. This inference is illustrated by the vaulted column of the beds and horizons in which the position of the Ephemeropsis Turganian Vitimian deposits is shown. Martinson writes that "the Turganian bed was previously regarded as a sort of collective concept covering all the lacustrine Mesozoic deposits in Transbaykaliya, whereas we now isolate it as a particular part of the whole profile" (1955 a:337) and in his new system Martinson indicates a Lower Cretaceous origin for the Turganskian bed. In another account, devoted to the lacustrine basins of Asia's geological past (1955 b: 78) he describes numerous lacustrine systems both of the Upper Jurassic and

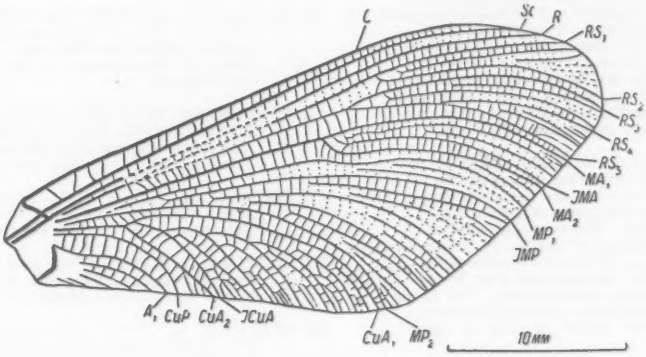

Fig. 7. - Ephemeropsis martynovae Chernova, sp.n. Fore wing. Coll. PIN No. 1668/846. Baysa. Upper Jurassic.

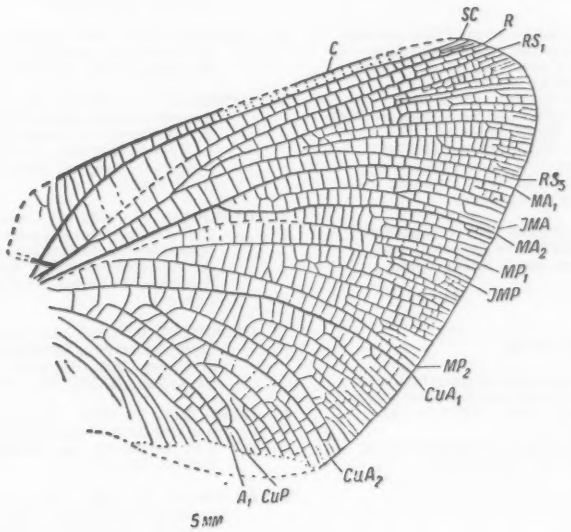

Fig. 8. - Ephemeropsis martynovae Chernova, sp.n. Hind wing. Coll. PIN No. 1668/862. Baysa. Upper Jurassic.

of the Lower Cretaceous, interconnected by rivers and streams and covering extensive expanses in central Asia, western and eastern Siberia, Mongolia and north and west China.

The Ephemeropsis nymph findings in north China, Mongolia and Transbaykaliya are undoubtedly evidence that the water bodies in this territory are connected and that there were similar small water bodies overgrown with vegetation. The morphoecological type of the Ephemeropsis nymphs makes this obvious. Three strongly pubescent caudal filaments and gills of lamellate shape indicate that they lived in the stagnant water of lagoons and lakes and in calm parts of lowland rivers. [3]

N. I. Novozhilov (1954), while studying Mesozoic fossil molluscs in Siberia, at the same time investigated the phyllopods of the Upper Jurassic and Cretaceous in Mongolia. In his monographs, apart from descriptions of newer material and a summary of the Phyllopoda taxonomy, Mesozoic continental deposits in Mongolia, China, Korea, Japan and other countries are compared. He notes (p. 118) that there are very few collections of Phyllopoda from Siberia and that the Mesozoic strata there have been very inadequately studied. Unfortunately, his comparative table of the Mongolian, Chinese, Japanese and British Phyllopoda includes only hypothetical data on the Transbaykaliyan Turganian beds, referred to an intermediate bed between the Upper Jurassic and the Lower Cretaceous. What is important for us, however, is that he definitely establishes the age of the Phyllopoda beds in Anda-Khuduk (Ondai-Sair) as Upper Jurassic, containing the same fauna as the classic profiles of the Purbeckian beds in Wealden (England).

Studying the new material of the winged stages of the Transbaykaliyan mayflies and comparing them with the data available previously, I have become convinced that there is an exceedingly great similarity of venation in Ephemeropsis and Hexagenites. The common features were mentioned in the descriptions of the family Hexagenitidae and of these two genera. So great a similarity in insects of the past undoubtedly indicates that they were related in time, if not completely synchronous. The genus Hexagenites has been described from certain Solenhofen shales, the Upper Jurassic age (Malm) of which is usually not disputed.

The great similarity between the general Hexagenites and Ephemeropsis thus shows that they were undoubtedly also closely related in time. This in turn indicates that the Turganian deposits (to be precise, those of the Vitim River below the mouth of the Baysa r.) belong to the Upper Jurassic, or to a period corresponding to the Malm of Western Europe.

Novozhilov's work contains confirmation of this conclusion. He established an Upper Jurassic age for the Anda-Khuduk beds. Fossil remains of Ephemeropsis are known from Anda-Khuduk. There is thus an analogy with the crustacean Phyllopoda from Anda-Khuduk, which are compared with the English Purbeckian and the Ephemeropsis, which is compared with the west European Malm. The Nalaykhian Ephemeropsis beds in Mongolia can also be regarded as Upper Jurassic. Again, the Jehol beds containing Ephemeropsis (north China) should be taken as Upper Jurassic rather than Lower Cretaceous.

Mayflies of the genus Ephemeropsis can be regarded as guide-fossils which, when found in new deposits, can help in determining the age of such strata as the Upper Jurassic.

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[3] Despite a certain similarity of venation in Ephemeropsis and Palingeniidae, nothing of the kind can be said of the nymphs, which resemble Siphlonuridae.

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A NEW SPECIES OF THE GENUS EUMETRIOPTERA MIR. (ORTHOPTERA, TETTIGONOIDEA) FROM THE MOUNTAINS OF THE SYR-DAR'YA KARATAU

A. A. BEKUZIN

During a reconnaisance survey of the south-western part of the Syr-Dar'ya Karatau (south Kazakhstan) in 1954 we collected a small amount of Orthoptera material, among which we noted several species of Tettigonia. By studying the sole specimen of Eumetrioptera Mir. and comparing it with the collections of the Zoological Institute, USSR Academy of Sciences in Leningrad we were able with the kind cooperation of Professors G. Ya. Bey-Biyenko and L. L. Mishchenko to identify a new species of this genus. In summer 1960 I was again able to visit the Karatau Mountains and to collect twenty-five specimens of this species. This means that we can now describe both sexes and that the main habitats of the species are known.

The species has been named after L. L. Mishchenko.

Eumetrioptera mistshenkoi, sp. n. (Fig. 1, 2)

Male. Large. Elytra with broadly rounded apex barely reaching the posterior margin of the 2nd abdominal tergite; Posterior margin of left elytron rounded and only slightly obliquely truncated on the inside; medial area of elytron dark brown. Cerci (Fig. 1) relatively long, not thick; viewed from above they gradually narrow towards the apex; the apical part of the cercus is broad, slightly acuminate, with a small, slightly recurved tooth. Hind femora sturdy; length of femur 4-4.2 times its greatest width, and with a brown preapical spot above, which sometimes stands out slightly. The upper side of the hind tibia has 25-29 spines on the outer margin and 24-29 on the inner; the underside has 6-7 on the outer margin and 6 on the inner.

Female. Very large. Elytra greatly shortened, falling just short of the middle of the first abdominal tergite; apex broadly rounded, with green fringe. Hind femora sturdy; length of femur 4-4.2 times its greatest thickness; a weakly perceptible preapical spot. Hind tibia dorsally with 25-29 spines on outer margin and 24-29 on inner; underside with 6-7 on outer margin and 6 on inner. 7th abdominal sternite with 2 longitudinal, slightly elevated ridges almost at the very margin. Additional membrane between 7th abdominal sternite and genital plate with 2 distinct lateral longitudinal tubercles. Genital plate finely punctuate with a median, distinctly elevated longitudinal ridge divided at the anterior margin; posterior margin with a deep, wide, rounded excavation medially. Ovipositor slightly recurved upwards, dark brown, basically light brown; its lower margin preapically covered with small distinct denticles.

Basic coloration of males and females lemon yellow, more rarely yellowish brown, with a greenish tinge in posterior half of upper side of pronotum and the elytra.

Body length: male 23.0-26.5, female 23-27 mm; pronotum, male 7.8-8.2, female 7.5-8.2 mm; elytra, male 2-2.5, female 1.4-2.1 (more often 1.5 mm); hind femur, male 18.5-19.5, female 19-22 mm; ovipositor 11.2-12.5 mm.

Distribution. Southern Kazakhstan. South-western slopes of Mt. Karatau; rocky slope in woody-shrubby zone in the upper reaches of the Borolday r. 1 female (allotype), 1 August 1954 (A. A. Bekuzin); same place, sandstone debris in woody, shrub zone in upper reaches of left upper tributary of the Borolday, 1 male, 3 females, 1 L female 13 July 1960 (A. A. Bekuzin); same place, sandstone debris in woody shrub zone in upper reaches of right upper tributary of the Borolday, 4 males, including holotype, 16 females (A. A. Bekuzin); Karatau Mountains, upper rock debris plateau above the small town of Baydzhansay with outcrop of parent sandstone rocks, 1 L male 17 July 1960 (A. A. Bekuzin).

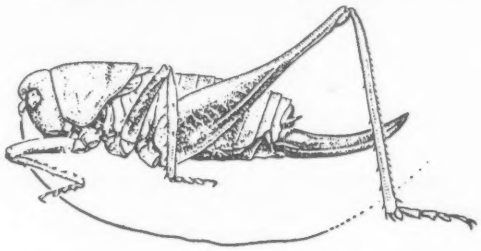

Fig. 1. - Eumetrioptera mistshenkoi, sp.n., type.

Fig. 2. - Right cercus of Eumetrioptera mistshenkoi, sp. n. (superior view).

The types are preserved in the collection of the Zoological Institute, USSR Academy of Sciences in Leningrad, and the paratypes in the Natural History Museum of the Uzbek Academy of Sciences, Tashkent. E. mistshenkoi

is sharply differentiated from all other species of this genus by its fairly large size, more elongated and well-proportioned hind femora and size of ovipositor. The arched ovipositor is more elongated (4.5 times its greatest width). Such an elongated ovipositor occurs only in the monotypical mountain genus Alticolana Zur, which is related to Eumetrioptera Mir.

In shape of body and coloration this species is most closely affiliated with E. monochroma Bey-Biyenko, known from Aktash in the Chirchik valley on the southern slopes of the Karzhantau range (western spurs of the Tyan'-Shan').

E. mistshenkoi lives among stones in dry gently sloping gullies and among waste falling in long belts on steep bare slopes, and follows a hidden way of life. It is characteristic that there is hardly any vegetation at all in the waste and no other insect forms. This meant that we had to shift a number of stones to find the Tettigonia. These agile insects would then make rapid leaps between the stones or momentarily hide in narrow clefts. The number of insects was relatively high. On one slope, for example, in the upper reaches of the Borolday, we found a specimen every one or two meters. Only occasionally were there two specimens under a single stone.

The favorite and characteristic habitat of this species seems to be rocky areas formed on steep waste slopes. Such locations occur in the woody shrubby zone of the Karatau at a height of 1000-1300 m above sea level.

In his review of the genus Eumetrioptera Mir. Mishchenko (1949) indicated a comparatively small area of this genus, bounded by the Turanian zoogeographical region (actually by the Karatau and Gissar ranges) and believed this region to be the modern development site of the genus. Our findings of a new species of the genus in south-west Karatau does not in fact alter the picture of the basic Eumetrioptera Mir. area but simply adds another mountain range (the Karatau).

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CONTRIBUTION ON THE STONEFLIES OF CAUCASIA

V: ARMENIA

L. A. ZHIL'TSOVA

The stoneflies of Armenia have never yet been studied and the collection material contributed by various people in Armenia is very scanty. The collections of the Zoological Institute of the USSR Academy of Sciences for example, contained only individual specimens of a number of families. For this reason I went to Armenia and from April to July 1956 visited a number of districts in the Republic and collected a considerable amount of Plecoptera material. These journeys were made possible only through the unstinted help and support of A. S. Avetyan, Director of the Institute of Zoology, Armenian Academy of Sciences, and the staff of that institute.

According to our data the number of species of Plecoptera known from Armenia is 27.[1]

Fam. TAENIOPTERYGIDAE

Brachyptera transcaucasica Zhil., Brachyptera sp. (sp. n.);

Fam. NEMOURIDAE

Amphinemura mirabilis (Mart.), A. trialetica Zhil., Nemura brevipennis Mart., N. variegata Oliv., Protonemura bacurianica Zhil., P. capitata Mart., P. microstyla Mart., P. vernalis Zhil., Protonemura sp.;

Fam. LEUCTRIDAE

Leuctra delamellata Zhil., L. hippopus Kemp., L. collaris Mart., L. martynovi Zhil., L. sanainica Zhil., L. zangezurica Zhil.;

Fam. CAPNIIDAE

Capniella schilleri Rost., Capnia nigra Pict., Capnia sp. (sp. n.).

Fam. PERLODIDAE

Perlodes microcephala Pict.

Fam. PERLIDAE

Perla kiritshenkoi Zhil., sp. n., P. pallida Guér., Perla sp. (sp. n.);

Fam. ISOPERLIDAE

Isoperla armeniaca Zhil., sp. n., I. caucasica Balin.;

Fam. CHLOROPERLIDAE

Chloroperla hajastanica Zhil., sp. n., Ch. teberdinica Balin.

[1] This summer will probably increase, as the investigation did not cover the whole territory of the Republic.

Among the stoneflies collected in Armenia 10 new species were identified.[2] Those belonging to the family Leuctridae have already been described (Zhil'tsova, 1960). Three new species from the families Perlidae, Isoperlidae and Chloroperlidae are described below.

On comparing the Armenian stonefly fauna with that of the whole Caucasus I found that 18 species occurred in the Little or Great Caucasus as well as in Armenia, that some were distributed throughout the Caucasus and that the remaining nine species were found only in Armenia. These were: Brachyptera sp., Protonemura sp., Leuctra sanainica Zhil., L. zangezurica Zhil., Capnia sp., Perla kiritshenkoi Zhil., sp. n., Perla sp., Chloroperla hajastanica Zhil., sp. n., Isoperla armeniaca Zhil., sp. n. Further research, particularly on the Little Caucasus and the contiguous countries (Iran and Turkey) will show whether the species enumerated are endemic in Armenia.[3]

Comparison with the west European fauna showed that of the 27 species mentioned in this paper only 5 were common to Armenia and Europe (Nemura variegata, Leuctra hippopus, Capniella schilleri, Capnia nigra, Perlodes microcephala); of the rest, known only from the Caucasus 15 have been described before (Martynov, 1928; Balinsky 1950; Zhiltsova, 1956, 1957, 1958, 1960) and seven are recorded for the first time, including six species new to science.

Because of their size the Perla species are the most noticeable component in the mountain river fauna. This genus is represented in the Caucasus by four species: P. caucasica Guér., P. kiritschenkoi sp. n., P. pallida Guér. and Perla sp. The Caucasus has no fewer species of this genus than western Europe; a number of local species seem to be endemic in that area. These well-marked species are distinguished also in having different distribution areas. P. caucasica is distributed in the Great Caucasus from Ciscaucasia to the Black Sea coast and Tbilisi; P. pallida occurs primarily in the Little Caucasus and Armenia and individuals are found on the southern slope of the Great Caucasus; P. kiritschenkoi sp. n. occurs in Armenia and Talysh and Perla sp. has so far been found only on the Armenian-Azerbaydzhan border (River Vorotan). Each species is thus identified with a particular region of the Caucasus.

The genus Isoperla is relatively poorly represented in the Caucasus.[4] The species are distributed as follows: I. caucasica Balin., a widely distributed species, is ubiquitous in the Great and Little Caucasus and in Armenia; I. rhododendri Zhil. is known so far only from the Trialetskiy range of the Little Caucasus; I. armeniaca does not extend

[2] The specific affinity of Protonemura sp. has not yet been established. It may be an eleventh new species.

[3] According to a communication from S. G. Lepneva, a number of caddis fly species which have long been known only from the Caucasus were lately found in Iran. Such species will probably be found among the stoneflies too.

[4] There are 2 Isoperla species which I do not include among the Caucasian species: 1) the doubtful species I. pulcra Balin. which, on my hypothesis, is a synonym for I. caucasica Balin.; 2) I. grammatica Poda; I question the record that this species has been found in the Caucasus.

outside Armenia; so, of the three species, only one I. caucasica, is distributed throughout the Caucasus and the other two have a more limited area.

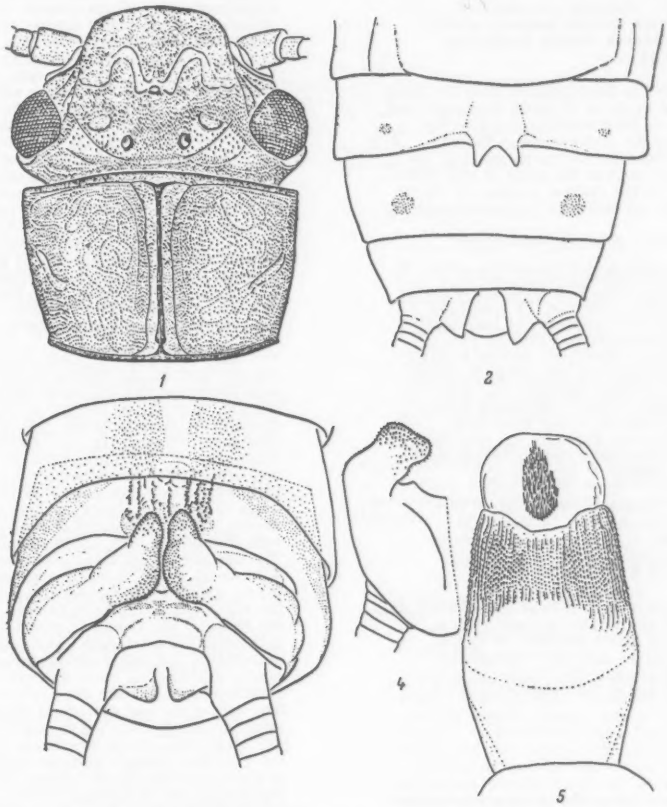
Of the genus Chloroperla five species have been found in the Caucasus (there are about ten in western Europe), distributed as follows: Ch. teberdinica Balin., the commonest, occurs from the northern slopes of the Great Caucasus to Armenia; Ch. sakartvella Zhil. has been found in the Great and Little Caucasus; Ch. katherinae Balin. occurs within the Great Caucasus; Ch. tripunctata Scop., a European species, has so far been found only in the Trialetskiy range of the Little Caucasus; Ch. hajastanica, sp. n. is distributed throughout Armenia. As can be seen, of the five Chloroperla species, one (Ch. teberdinica) occurs throughout the Caucasus and the areas of the other species are limited to one or another part of the region.

One of the newly described species, Perla kiritschenkoi, sp. n., has been named after the eminent entomologist A. N. Kirichenko, who devoted much energy to studying the Caucasian insect fauna and was the first to collect this species. The name of a second species, Chloroperla hajastanica sp. n., it sormed from 'Aystan', the Armenian word for Armenia. The types of the species described are preserved in the ZIN collections.

Fam. PERLIDAE

Perla kiritshenkoi: Zhil., sp. n. (Figs. 1-5)

Body length male 13-16.5 mm, female 18.5-24-5 mm; length of fore wing, male 14.5-18 mm, female 21-26.5 mm; wing spread, male 32-33.5 mm, female 45-55.5 mm (11 males and 20 females from the dry collection were measured). The body is comparatively small, smaller than the European Perla species (according to the data of Illies, 1955 and Despax, 1951). Length of male body as in Perla marginata and P. stancovici Sam. and smaller than in other European species. Anterior half of body (head and thoracic segments) dorsally dark, from dark brown to blackish, abdomen light colored, a dirty yellow in the female (sometimes bright yellow) and darker in the male, rusty or brownish. The underside of the body is yellowish, the thoracic sternites partially brownish in the male body slightly darker. Head (Fig. 1), dark brown with lighter rusty areas between the posterior ocelli and the eyes (in some specimens the light areas merge into one transverse band behind the posterior ocelli); Cephalad of the M-shaped line is an indistinct light spot and at the anterior margin of the head there are two indistinct light spots; antennae dark; M-shaped line clearly defined, smooth, dark; frontal tubercles convex, distinctly outlined, lenticular, shiny, lighter than the rest of the head surface; light parts caudad to these usually depressed. Pronotum (Fig. 1) almost the same width as the head with eyes, posteriorly gradually narrowing, with a slightly arcuate anterior margin; coloration the same as that of the head, medial band concolorous with lateral areas; vermiform rugosities on lateral areas fairly distinct and a smooth, oblique, lighter band near the lateral margins of the dorsum. Mesonotum and metanotum dark, shiny. Legs and cerci slightly lighter than head and dorsum



Figs. 1-5. - Perla kiritshenkoi Zhil., sp.n. 1 - head and pronotum of female; 2 - apex of female abdomen, ventral view; 3 - apex of male abdomen, dorsal view; 4 - hook-shaped process of 10th tergite in male, lateral view; 5 - copulatory organ of male, ventral view.

or concolorous with it; tibiae lighter below each joint of the cerci lighter at the base than at the apex. Wings hyaline, brownish piceous, with dark brown veins; costal and anal veins of hind wing pale, slightly brownish; venation typical. The coloration features peculiar to the species are less well marked in the male. Cerci long, protruding well beyond the tips of the wings, their length equal to or slightly greater than that of the abdomen.

Male (Fig. 3). 9th Sternite slightly prolate, forming a rounded subgenital plate. 8th tergite medially depressed, with dense and thickened hairs on both sides of the median furrow. 9th tergite with dorsal plate,[5] composed of brown longitudinal denticulate combs; width of plate slightly greater than or equal to its length; combs high, as can be seen in lateral view, usually 7 in number, those at the edge being lower than those in the middle; combs of dorsal plate not reaching the posterior margin of the 9th tergite and bordered by a glabrous sclerotized rounded area. Hook-shaped processes of 10th tergite sharply curved and antrorse; apical part of hook decurved, as can be clearly seen in lateral view (Fig. 4). From the bend to the apex the hook is medially covered with dense short spinelets. Penis (Fig. 5) slightly depressed in the dorsoventral direction and apparently flattened; membranous apex prolate within stipes of penis, armature on its ventral surface,[6] consisting of a tuft of long flat spinelets; denticular area relatively narrow, occupying roughly a quarter of the length of the trunk; the area twice as long as it is wide.

Female (Fig. 2). Sternites not modified. Posterior margin of 8th sternite medially with 2 small triangular apophyses similar to those of P. burmeisteriana Claas.

The species described is distinguished from the other two Caucasian species of Perla by the body coloration and by the structural details of the dorsal plate on the 9th tergite and of the hooks of the 10th tergite in the male. It is similarly differentiated from the European species; the structure of the denticular area of the penis is also different. Perla kiritshenkoi is the darkest in color of all the species, with the possible exception of P. burmeisteriana.

Distribution: Caucasus: Armenia and Talysh.

Material studied (dried collection, partly in alcohol). Armenia: vicinity of Stepanavan. Kamenka rivulet, 25 June 1956 (1 female) 27 June 1956 (4 females); L. Zhil'tsova); left bank of Dzoraget river tributary above Stepanavan, 26 June 1956 (3 females; L. Zhil'tsova); Dzhelal-Ogly (now Stepanavan, Kamenka river gully, 16 May 1922 (6 males, 3 females, including 1 male, holotype: A. Shelkovnikov), 29 May 1920 1 male); Marmarik River, near village of Tsakhkadzor, 8 July 1956 (7 females, including 1 female, allotype; L. Zhil'tsova); Armenia, vicinity of Yerevan, 31 May 1925 (1 male, 1 female; A. Shelkovnikov).

Talysh: Lerik, Lenkokranskiy hamlet, 13 May 1909 (2 males; Kirichenko), 14 May 1909 (1 female; Kirichenko); Lyulyakeran', Lenkokranskiy hamlet, 15 May 1909 (1 male; Kirichenko), 16 May 1909 (1 female; Kirichenko).

Flies from second half of May to first half of July; adult insects occur in Armenia at altitudes of 1400-1850 m, on banks of rapid streams and small mountain rivers in forest zone, on cereal grasses and other herbaceous plants. Occurs in Talysh at altitudes of approximately 1500 m at the upper boundary of the forest zone (Lerik) and above.

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[5]Despax calls the armature of the 9th sternite "plaque dorsale" (Despax, 1942: 69).

[6]"Zahnfeld" (denticular area) in Illies's terminology (1955:108).

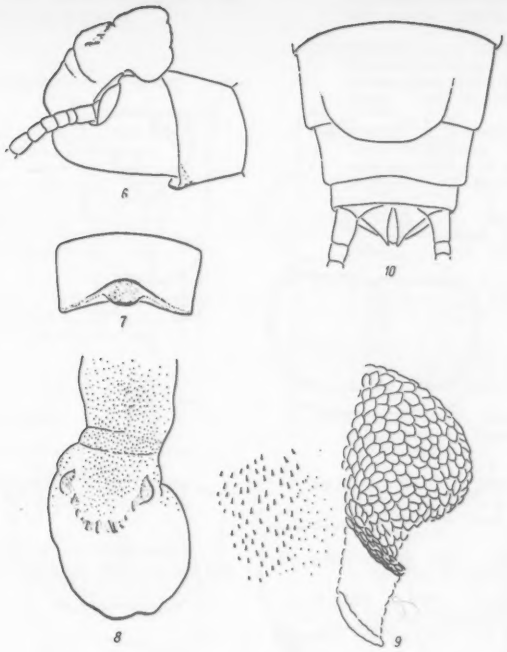
Fam. ISOPERLIDAE

Isoperla armeniaca Zhil., sp. n. (Figs. 6-10)

The following description is based on dried and alcohol-preserved specimens in the ZIN collection of the Academy of Sciences, USSR. Body length, male 7-10 mm, female 8-12 mm; wing spread, male 16-20 mm, female 19-26 mm (30 specimens of each sex were measured). Body relatively small (for Isoperla), coloration light (type I. grammatica Poda). Head yellow with distinctly outlined reniform markings between ocelli, anterior margin of this figure sometimes angular rather than rounded; M-shaped line slightly infuscate, surface of head in front of it brown, two brown spots near anterior margin of head, sometimes merging with brown medal surface of head; tubercles laterad of the anterior ocellus brownish; occiput brownish, with a median colored section in the shape of a triangle almost meeting the posterior ocelli. First antennal segment brown, the next few segments (usually 7 or 8) light, the rest brownish. In the light-colored specimens a darker distal termination is distinguished on each segment. Palps brownish. Pronotum somewhat lighter than head, light yellow, with a broad median band; lateral areas slightly infuscate with distinct light brown sculpturing (rugosities); anterior margin with a broad brown band interrupted medially posterior margin with a narrow band; median line light colored. Prescutum and anterior half of scutum (not covered by wings) light; remainder of mesothoracic surface and entire metathorax brown; meso- and metapleura slightly brownish or yellow with brown sutures. Wings hyaline, very slightly infuscate, along costal margin yellow in the basal part of the wing; veins thin, light brown, C, R and Cu_1 slightly darker than the rest, C and R basally light. Legs yellowish, femur, tibia and tarsus above brownish, femur with dark oval spot at base. Abdomen somewhat lighter than mesonotum and metanotum, brown above, the brown parts of individual segments in the male forming a broad longitudinal band which gradually narrows posteriorly. Ventral surface of body in both sexes completely light colored, pale yellow or whitish. Body coloration as in other Isoperla species, varies considerably. The peculiarities of coloration described above are more clearly visible in the specimens preserved in alcohol; on drying the color pattern is greatly distorted. Cerci yellow, with slender segments; distal termination of each segment brown, the last segment being entirely dark.

Male (Figs. 6-9). Ventral plate (apophysis of 8th sternite) relatively short, wider than long, light brown, with a distinctly outlined posterior margin, sclerotized margin of 8th segment, dividing the plate from the rest of the surface, prominent, brown (Fig. 7). Armature of penis (Fig. 8) on bulging penal sac has the appearance of a strongly curved brown band with uneven margins, running at an angle to the tip of the organ; this band is of uneven width, terminally dilated and rounded, with transverse folds throughout its length. The surface of this sclerotized band is covered with small, short, closely appressed scales (Fig. 9); the armature is weakly translucent through the 9th sternite; when the penial sac is retracted the shape of the armature alters slightly to form a U instead of a triangle, the margin of the sclerotized line being almost parallel, and the combs standing out more sharply; there is no additional armature in the species described. The rest of the sac surface is covered with small spinelets, varying in length (Fig. 9). The type of the penial armament in I. armeniaca sp. n. is thus sharply distinct from that of other species in which this structure has been described; there is a distant resemblance to I. obscura Zett., but the armature of the latter consists of individual large dilated spines, whereas in our species it is a plate covered with small scales.

Female (Fig. 10). Subgenital plate of usual



Figs. 6-10. - Isoperla armeniaca Zhil., sp.n. 6 - extremity of male abdomen with evaginated copulatory organ, lateral view; 7 -8th sternite of male; 8 - male copulatory organ, extruded from abdomen; 9 - right, scales of armature on copulatory organ, greatly magnified; left, spinelets covering surface of copulatory organ medially from armature; 10 - apex of female abdomen, ventral view.

form, its posterior margin rounded or slightly angular, sometimes with a small medial excavation; plate extending slightly into 9th sternite (covering 1/3 to 1/2 its length).

The species is clearly distinguishable from L. caucasica Balin., which is widely distributed in the Caucasus, by the following peculiarities: relatively small body, over-all light yellow coloration of the body, light cerci with dark rings, femur with a dark patch at the base, wide medial band on the pronotum, longer cerci and segments thereof, short ventral plate and armature of the penis in the form of a sclerotized band with combs.

Distribution: Armenia.

Material studied (alcohol-preserved and dried):[7] Kura r. basin (Debet r. with tributaries): Kamenka r. (vicinity of Stepanavan), 25 June 1956 (1 female), 27 June 1956 (5 males, 3 females); tributary of Dzoraget r. above Stepanavan, 26 June 1956 (31 males, 4 females); Pambak r. (Debet below Kirovakan), 21 June 1956 (43 males, 23 females); Pambak r. at village of Spitak, 23 June 1956 (193 males, 81 females, including 1 male, holotype and 1 female, allotype).

Araks R. basin Kasakh r. at village of Ashtarak, 15 June 1956 (18 males, 8 females); Kasakh r. at village of Aparan, 11-12 July 1956 (1 male, 7 females); Razdan r. (Zanga), 13 June 1956 (1 male); 8 July 1956 (2 males, 1 female); Marmarik r. (tributary of Razdan, at village of Tsakhkadzor) 8 July 1956 (1 female); Yerer r. (tributary of Arpa), 22 May 1956 (4 males, 3 females); Vorotan r. at Shaki waterfall, 15 July 1956 (4 males, 7 females); rivulets above village of Dastakert, 16 July 1956 (7 males, 15 females); Ayriget r. (Vorotan basin), 16 July 1956 (35 males, 26 females); Zabukh r. (tributary of Akera) 18 July 1956 (9 male, 7 females); Vokhchi r. (at Kadzharan) 24 July 1956 (2 males, 5 females); Megriget r. at village of Vartanadzor, 5 July 1956 (4 males, 5 females).

The adult insects are found from the end of May to the end of July at altitudes of 1100 m (Ashtarak) to 2000 m (Aparan), both in small mountain rivulets and in comparatively large rapid rivers (for example Razdan and Megri).

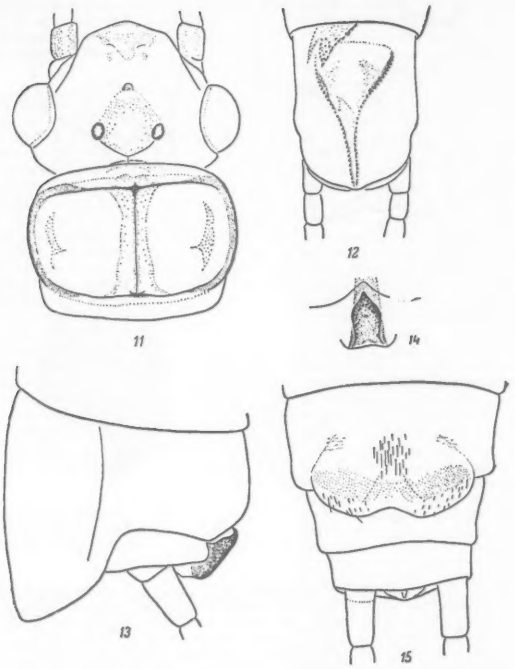
[7]Material collected by author.

Fam. CHLOROPERLIDAE

Chloroperla hajastanica Zhil., sp. n. (Figs. 11-15)

The description is based on specimens preserved in alcohol.

Body length, male 6.5-7.5 mm (type 6.5 mm), female 7-8 mm (type 7.5 mm); fore wing: male 7-9 mm (type 8.5 mm); female 7-9.5 mm (type 9 mm). General body color light yellow. Head (Fig. 11) yellow with a transverse brown spot forward on clypeus, space between ocelli brownish, partly uncolored; ocelli bordered with dark pigment. First antennal segment brown, the next 4 or 5 light colored, the rest brown. Pronotum (Fig. 11) with a distinct dark brown median line; median band sometimes brownish, but more often yellow; lateral margins bordered



Figs. 11-15. - Chloroperla hajastanica Zhil., sp.n. 11 - head and pronotum; 12 - apex of male abdomen, ventral view; 13 - extremity of male abdomen, lateral view; 14 - supra-anal hook of male, dorsal view; 15 - apex of female abdomen, ventral view.

with a brown band; dark pleura translucent through integument of pronotum. Mesonotum and metanotum with dark brown anchor-shaped marking, medially brownish, mesonotum cephalad of anchor uncolored. Femora and tibiae superiorly brownish, tarsi darker. Brownish areas on head, dorsum and legs sometimes weakly perceptible. Wings hyaline, yellowish, with pale yellow veins; in dried specimens the wings somewhat brighter, greenish-yellow; anterior wing margin between C and R, yellow. Abdomen slightly yellowish, with fairly broad dark brown band, slightly constricted posteriorly, consisting of 6 spots on 2nd to 7th segments, with 2 additional small spots near the anterior margin of the 8th tergite in females and one small transverse spot at the anterior margin of the 8th tergite in males; in the females the 10th segment above, the 9th segment laterally and the posterior margin brownish; in the male the 9th segment slightly brownish above with a light spot at the posterior margin. Cerci light-colored, the last 2 or 3 segments brownish.

Male. Subgenital plate of male (Fig. 13) slightly elongate, terminally rounded or slightly accuminate; the outline of the copulatory organ (Fig. 12) translucent through the 9th sternite, apparently similar in structure to that of Ch. neglecta Rost. and Ch. burmeisteri Pict.[8] In Ch. burmeisteri and in the species we are describing the copulatory organ is situated within the 9th segment; in Ch. neglecta it is in the 7th and 8th segments. The supra-anal hook (Figs. 13 and 14) is blackish brown, running forward at an angle, basally wide and apically narrowed, accuminate, with decurvate apex; in profile it is similar to the hook in Ch. neglecta (according to Aubert's drawings, 1956: 211, Figs. 52 and 53) and Ch. burmeisteri Pict. (according to Brinck's drawing, 1949: 78, Fig. 8); above the hook is broad, apically accuminate; surface of 10th tergite medially brown.

Female (Fig. 15). subgenital plate with a small excavation at posterior margin, dividing it into 2 circular lobes and with broad brown band, translucent through the plate, not far from the posterior margin; hairs in median part of plate longer than on the rest of its surface, forming a tuft which is conspicuous in profile.

Of the Caucasian species, Ch. teberdinica Balin. resembles the species here described in body coloration; its brown coloration is more distinct and occupies larger areas on the head and dorsum. Among the European species there is some resemblance in color to Ch. burmeisteri and Ch. neglecta and a slight resemblance to Ch. torrentium Pict. In body size our species is larger than Ch. sakartvella Zhil. and Ch. teberdinica Balin., but smaller than Ch. katherinae Balin.

[8]The structure of the copulatory organ in Ch. neglecta and Ch. burmeisteri is illustrated in the papers by Aubert (1956: 212, Figs. 54 and 55) and Brinck (1949:78, Fig. 8)

In Illies's key (1955: 115-120) this species is placed in the same series as Ch. neglecta and Ch. burmeisteri.

Distribution: Armenia.

Material studied (alcohol-preserved and dried collection).[9]

Araks river basin: Razdan r. (Zanga)above village of Akhta, 13 June 1956 (1 male, holotype, 1 female, allotype, 3 males and 7 females, paratypes); Marmarik r. (tributary of Razdan), below village of Tsakhkadzor, 13 June 1956 (3 females), 8 July 1956 (4 females); Kasakh r. at village of Aparan, 12 July 1956 (2 males, 26 females); Kashuni r. south of the village of Shurnukhi, 20 July 1956 (1 female).

Flies in June and July. Occurs at altitudes from 1500 to 2000 m on herbaceous vegetation both on the banks of certain large rivers (Razdan) and of small mountain rivulets.

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APHIDS (HOMOPTERA, APHIDOIDEA) INJURIOUS TO SALSOLACEAE

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The various species of Salsolaceae and related genera form part of a group of plants used to bind sands, particularly in strongly alkaline districts. Moreover, as Salsolaceae are widespread in desert and steppe regions they are used as fodder for camels, sheep and other livestock. Shrub Salsolaceae are good planting material, since cuttings of them quickly take root. Among the insects found on these plants, aphids are particularly numerous.

The species composition of the aphid fauna injurious to Salsolaceae can be discovered only by examining a whole group of plants of related genera, since aphids living on one of them can freely live on any other. This paper therefore deals with a group of plants related to Salsolaceae, including Anabasis, Salsola, Suaeda, Girgensohnia and a number of other genera. The aphids infest the top shoots and leaflets or form large accumulations all over the plant (Xerobion eriosomatinum Nevs. on summer cypress). Few species of aphids are found on Salsola and nearly all the species are oligophagous, only Aphis medicaginis Koch being polyphagous.[1]

The following species have been recorded:

1. Chaitaphis tenuicauda Nevs. On the tips of the shoots and leaflets of Kochia prostrata and Salsola lanata. Central Asia (Nevskiy, 1929).

2. Clypeaphis stavropolensis Ivanovskaya (1960) (see Fig. 1).

Opterous fundatrigenia (Salsola sp., Stavropol'sk territory, 30 June 1914, Uvarov). Body broadly ovate, covered with sparse hairs, with pale antennae, cornicles, legs and cauda; eyes red. Cuticle reticulate, the cells indistinct and prolate in the form of oblong scales only in the region of the 7th and 8th abdominal segments. Marginal tuberclos distinct on prothorax, not very conspicuous on Ist, and very small on 7th, abdominal segment. Spiracles oval, under overhanging folds of stigmal plates. Frons convex, with pronounced antennal tubercles. Clypeus protruding sharply for half its length beyond the anterior margin of the frons. Antennae 6-segmented, 5th and 6th segments tegular, persistent rhinarium of 6th segment with three (3-4) additional rhinaria and a corona of cilia. Unguis of 6th segment with three apical setae, one at the very apex and two at a right angle below it. Eyes normal, with triple-facetted tubercle Rostellum extending beyond hind coxae, 3rd segment with four hairs, 6th with 14 (6 + 8). Legs covered with sparse but stout hairs, half the diameter of the 3rd antennal segment. Setae on first tarsal joint 3-3-3. Coalescence of abdominal tergites normal. Cornicles medially slightly distended, running along the abdomen. Cauda digitiform but distinctly dilated basally, with 5-6 lateral hairs. Anal plate almost square with small hairs.

Body: 1.90 x 1.17 mm; antennae: 0.87 mm (3rd -0.23 x 0.03, 4th -0.15, 5th -0.16; 6th -0.11-0.13); rostellum: 3rd -0.08 mm, 4th -0.12 mm; cornicles: 0.10 x 0.04 mm, cauda 0.23 x 0.11 mm.

On Salsola sp., Stavropol'sk territory (Uvarov, 1914).

This species is destinguished from Clypeaphis suaedae Solim., by the body shape, position and number of hairs on the rostellum and cauda, a number of additional rhinaria on the 6th antennal segment and the structure of the cuticle, which is coarsely and distinctly reticulate. The appressed cornicles ressemble those of Aspidaphis Gill., except that the aperture is situated at the apex instead of at the side. In other characters Clypeaphis stavropolensis Iv., is very unlike Aspidaphis Gill. The strongly developed clypeus, structure of antennae and frons, number of setae on the 1st tarsal segment and shape and structure of the cauda refer this species to the genus Clypeaphis Solim.

The type specimen (Stavropol'sk territory, 30 June 1914, Uvarov) is preserved in the ZIN, AN SSSR.

3. Clypeaphis suaedae Solim. On the tips of sprigs of Suaeda vera, S. maritima, Salsola sp. Britain (Gimingham, 1942; Gimingham and Gimingham, 1944); Egypt (Soliman, 1937, 1938); Western Kazakhstan (Shaposhnikov, 1952).

4. Aphis medicaginis Koch. On the tips sprigs of Kochia hissopifolia. Central Asia. (Nevskiy, 1929).

5. Xerobion eriosomatinum Nevs. Large colonies all over the plant, on stems and leaves of Kochia prostrata. Ukraine (Bozhko, 1950a, 1950b, 1953a, 1953b, 1953c); Western Kazakhstan (Shaposhnikov, 1952): Uzebkistan (Nevskiy, 1929).

[1] The material used for this work is from ZIN collections Academy of Sciences, USSR, which have not been worked over.

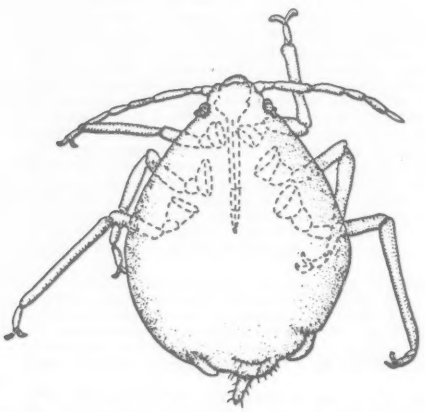

Fig. 1. - Clypeaphis stavropolensis Iv., apterous fundatrigenia.

6. Xerophilaphis berezhkovi Iv. On tips of Salsola Richteri sprigs in small colonies, very mobile, with ants. Turkmenia (Ivanovskaya, 1959).

7. Xerophilaphis salsolacearum Nevs. On ends of stalks and sprigs of various Salsolaceae, Salsola, sp., Girgensohnia opositiflora, Caroxylon arborescens, Anabasis sp. and others. Azerbaydzhan (Rusonova 1942), Kazakhstan, Turkmenia, Uzbekistan (Nevskiy, 1928, 1929).

IDENTIFICATION KEY FOR APHIDS INFESTING SALSOLACEAE

1 (2). Unguis of 6th segment not less than twice as long as its base. Almost black, adults sometimes with sheen ..... Aphis medicaginis Koch.

2 (1). Unguis of 6th segment shorter than its base, or if longer, not more than one and a half times as long. Different coloration, without sheen, or with pollination.

3 (4). Body hairs split fanwise, long (about 0.05 mm). Not greenish pollinoise ..... Chaitaphis tenuicauda Nevs.

4 (3). Body hairs simple, short (about 0.02-0.03 mm). Body pollinose.

5 (6). Clypeus not protruding beyond anterior margin of frons. Pollen in the form of long waxy fibres forming sharp body markings ..... Xerobion eriosomatinum Nevs.

6 (5). Clypeus emerging beyond anterior margin of frons. Pollen in the form of a light bloom over the whole body.

7 (10). Cornicles slightly distended medially but narrowed basally and apically. Cauda digitiform. Setae on 1st segment 3-3-3.

8 (9). Body broadly ovate. Persistent rhinarium of 6th antennal segment with 3-4 additional rhinaria. Cauda with 5-6 lateral hairs. Cornicles short..... Clypeaphis stavropolensis Iv.

9 (8). Body narrowly ovate. Persistent rhinarium of 6th antennal segment with 6 additional rhinaria. Cauda with four lateral hairs. Cornicles long ..... Clypeaphis suaedae Solim.

10 (7). Cornicles differently shaped. Cauda conical Setae on 1st tarsal segment 3-3-2.

11 (12). Frons with four hairs. 6(4+2) hairs on 6th segment of rostellum. Tail with ten lateral hairs. Body well proportioned, narrowly ovate, light green ..... Xerophilaphis berezhkovi Iv.

12 (11). Frons with eight hairs. 8(6+2) hairs on 6th segment of rostellum. Tail with seven lateral hairs. Body sturdy, broadly ovate, yellow-green..... Xerophilaphis salsolacearum Nevs.

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CLICK BEETLES OF THE GENUS MEGAPENTHES KIESENW. (COLEOPTERA, ELATERIDAE) IN THE FAUNA OF THE U.S.S.R.

YE. L. GUR'YEVA

According to the Junk and Schenkling catalogue (1925-1927) and subsequent descriptions, the genus Megapenthes Kiesenw. now contains 266 species, the overwhelming majority of which inhabit tropical regions in the Old and New World. In Palaearctica this genus is represented by 31 species, distributed primarily in the south and southeast of that zoogeographical region: 25 species in Japan, 4 in China, 1 in Korea, 1 in Southern and Central Europe, the Caucasus and North Africa, 1 in the Caucasus and Iran. On going over the material in the ZIN collections of the AN SSR we found in V. V. Gussakovskiy's collections yet another species of this genus, new to science, from Tadzhikistan.

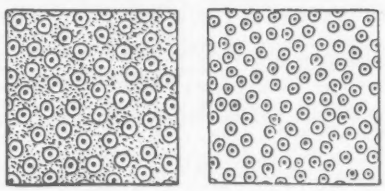
This means that on the 31 species distributed in Palaearctica 3 have been found in the USSR fauna: M. lugens Redt., M. rutilipennis Cand. and M. gussakovskii, sp. n.

The genus Megapenthes belongs to the tribe Elaterini of the subfamily Elaterinae. The beetles of this genus are distinguished by the well proportioned, long body; the presence of a tooth on the inner margin of the metacoxal plate; the straight furrow of pronotum which is not impressed anteriorly; the slender antennae segments 4 to 10 are of uniform width or become thinner and longer towards the apex of antenna and are serrate from the 4th segment onward; the absence of a carina on the frons, the anterior margin of which is more or less rounded; and the very distinctive character of the excavation at the apex of the elytra. The scutellum is usually in the shape of a long and narrow triangle.

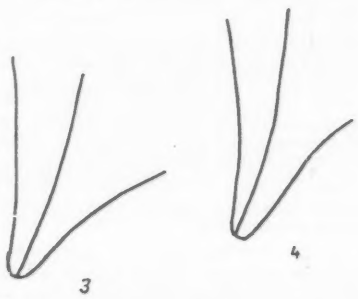
Two groups of species can be clearly distinguished, one with two carinae in the posterior angles of the pronotum and the other with only one. All the Soviet species belong to the second group.

Sexual dimorphism is observable in the Soviet species; the females are usually slightly larger than the males; their antennae do not reach the posterior margin of the pronotum, whereas in the males they extend by one or two segments beyond its posterior angles; and the third antennal segment in the females is slightly larger than the second, whereas in the males it is of the same size.

The only published data on the biology relate to one of the commonest European species, M. Lugens Redt., about which it is known that the larvae develop in old rotten wood of deciduous trees, usually infested with the longhorn beetle Rhamnusium bicolor Schrank (F. Husler and J. Husler, 1940; Jablokow, 1940). M. lugens Redt. swarms during a very brief period in early spring from late April to early May (F. Husler and J. Husler, 1940).



Figs. 1-2. - Sculpturing of pronotum: 1 - Megapenthes lugens Redt., and M. rutilipennis Cand. 2 - Megapenthes gussakovskii, sp. n.



Figs. 3-4. - Posterior angles of pronotum: 3 - Megapenthes lugens Redt. 4 - Megapenthes rutilipennis Cand.

KEY TO SPECIES IN THE USSR FAUNA

1 (4). Species between punctures on pronotum very finely scabrous, mat (Fig. 1). Medium furrow present only on posterior declivity of pronotum and occupying not more than one fifth of its length.

2 (3). Carina on posterior process of pronotum situated medially and dividing it into halves (Fig. 3). Entirely mat black, covered with very slender black hairs. 7.5-11 mm. Western, Central and Southern Europe, the south of the European part of the USSR, Caucasus, Algeria ..... M. lugens Redt.

3 (2). Carina on posterior process of pronotum situated nearer the outer margin (Fig. 4). Head, pronotum and venter black, elytra brick red. Black parts covered with very fine, short, black, and elytra with similar yellow, hairs. 7-11 mm. Caucasus (Talysh), Iran ..... M. rutilipennis Cand.

4 (1). Spaces between punctures on pronotum scarbrous, shiny (Fig. 2) Median furrow distinct to not less than one quarter of the length of the pronotum. The whole beetle reddish-brown, the pronotum and venter rather paler than the elytra. Legs yellow. Dorsum and venter covered with a yellow silky pubescence. 5-5.1 mm. Tadzhikistan, Vakhsh River valley..... ..... M. gussakovskii, sp. n. (Fig. 5).

Megapenthes gussakovskii, sp. n.

The whole beetle reddish-brown; head, antennae, pronotum and venter paler than elytra; first three antennal segments and legs almost yellow; eyes black, dorsum and venter covered with golden yellow silky pubescence.

Length and breadth of head roughly equal, very coarsely covered with large dense punctures;

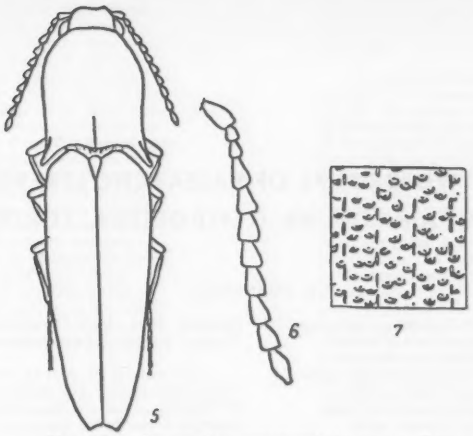


Fig. 5-7. - Megapenthes gussakovskii, sp.n.; 5 - general view; 6 - antenna; 7 - elytral sculpturing.

frons strongly convex.

Tips of antennae do not extend beyond the posterior angles of the pronotum; 1st antennal segment large, distended, longer than wide; 2nd and 3rd equal in length, and 2nd being as long as it is wide and the 3rd longer than wide. From the 4th segment onwards the antennal segments are serrate, their length greater than their apical width (Fig. 6).

Pronotum convex, its length exceeding its width, its greatest width nearer the anterior margin and roundly narrowed anteriorly and cephaled of the posterior angles of the pronotum. Posterior angles of pronotum running caudad and laterad, each bearing one carina situated nearer the outer margin. Median furrow distinct, deep and traceable from the base of the pronotum to roughly a quarter of its length. Pronotum covered with coarse umbilicate punctures, the spaces between these being smooth and shiny and in places equal to the diameter of the punctures, in other places less.

Prosternum covered fairly densely with very small fine punctures; pronotal epipleura more densely and coarsely punctate than the prosternum but with smaller punctures than the pronotum.

Scutellum strongly prolate, forming a triangle.

Elytra not broader than pronotum, their length almost three times their greatest overall width. Immediately behind the shoulders, the elytra can barely be seen to narrow, and only approximately in the last quarter do they narrow sharply toward the tips. Excavations at tips of elytra rather shallow. Elytral surface between punctate furrows uneven, heavily pimpled, this pimpling being particularly apparent at the bases of the elytra, (Fig. 7).

Abdomen covered with shallow but dense punctation. Length 5-5.1 mm, width 1-1.1 mm.

Material. Tadzhikistan; steppes between the Vakhsh R. and Ak-Tau range near Mikoyanabad (formerly Kabadian), 16 June 1934, V. V. Gussakovskiy (2 males, including a holotype); Dzhilikul' on Vakhsh, R. 12 June 1934, V. V. Gussakovskiy (1 male).

In outward appearance the newly described species most resembles M. rufus Cand., known to me only from the description from India. It differs from this however, as far as I can tell, in coloration – in having light-colored legs; and also in being much smaller and having the posterior angles of the pronotum running caudad and laterad and bearing only one carina.

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REVIEW OF TWO GROUPS OF PALEARCTIC LEAFROLLERS OF THE GENUS PAMMENE HB. (LEPIDOPTERA, TORTRICIDAE)

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The large and faunistically poorly studied genus Pammene Hb. (Phthoroblastis Ld.), many representatives of which are forest and orchard pests, can be divided into natural groups of species, or sections, that have arisen phylogenetically, probably on the basis of food specialization. The sections obscurana and rhediella are particularly difficult to identify since they unite closely related species with little external difference and extremely similar structure of the genital apparatus. References to these leafrollers in the literature are fragmentary, extremely contradictory and marked by a high level of confusion in the use of synonyms.

The scope of the present review has been restricted to a redescription of the leafrollers in these two sections and to a consideration of their taxonomic position and synonomy. The description of the moths has been based on the nomenclature for the stripes and spots adopted by Kennel (1921), counting the costal striae from the apex of the wing.

The main materials (ownership of which by foreign museums is not specially indicated) are in the collections of the Institute of Zoology (USSR Academy of Sciences) in Leningrad. Valuable specimens, including some types, were also obtained for study from the British Museum (London), the University Zoological Museum in Helsinki and the State Natural History Museum in Karlsruhe. I am deeply grateful to A. S. Danilevskiy and M. I. Fal'kovich (Leningrad) for extensive help in my work. I also wish to thank the following for materials, valuable comments and corrections: Dr. G. Amsel (Karlsruhe), D. Bradley (London), N. Wolf (Copenhagen), F. Kayzer (Basle), U. Kaysila (Helsinki), I. Klimeš (Linz) and S. Toll (Katowice).

THE SECTION OBSCURANA

The literature contains seven original descriptions relating to Palearctic species of this group: Pseudotomia obscurana Stph. (Stephens, 1834); Grapholitha tomiana Z. (Zeller, 1868); Grapholitha clanculana Tgstr. (Tengström, 1869); Steganoptycha luedersiana Sorh. (Sorhagen, 1885); Pammene agnotana Rbl. (Rebel, 1914); Pammene engadinensis M.-Rutz (Muller-Rutz, 1920); Pammene snellenana Bent. (Bentinck, 1947). It is typical that the majority of these species were initially allocated to genera that were sometimes very far from Pammene Hb. For example, Meyrick initially classified the first of the species of this group (Pseudotomia obscurana Stph.) as a new genus Sphaeroeca Meyr., and then transferred it to the genus Eucosma Hb. (Meyrick, 1927); and it was only in 1951 that it was finally confirmed in Pammene Hb. after the first attempt of Pierce (Pierce and Metcalfe, 1922). In this case the taxonomic position altered because of the unsatisfactory original description by Stephens and because the specimens studied were few and often, apparently, deformed during mounting. When Kennel published his revision (1921) he knew the first four species in the list given above, and made the first attempt to distinguish between them. He transferred Steganoptycha leudersiana Sorh. to the genus Pammene Hb., but retained the monotypic genus Sphaeroeca Meyr. for Sphaeroeca obscurana Stph., and included both Grapholitha tomiana Z., and Paedisca ravulana H.-S. as synonyms for Stephens' species. He was not familiar with Grapholitha clanculana Tgstr. in the live state, and mistakenly identified specimens from Northern Scandinavia which probably belong to this species as S. obscurana Stph. Thus, the species "Sphaeroeca obscurana Stph." as understood by Kennel is a collective species; its redescription based on confused material is unsatisfactory; and the drawing (Kennel, 1921, Vol. 20: 61) is probably of P. clanculana Tgstr., judging by the position of the dorsal spot.

The second attempt to revise Kennel's species "S. obscurana Stph." was undertaken by Obraztsov (1951). He classified the species included in this collective concept in the genus Pammene Hb., mistakenly restored the independence of P. ravulana H.-S., separated P. tomiana Z. from P. obscurana Stph. and took Tengström's species P. clanculana Tgstr., as an early synomym of P. obscurana Stph. In a subsequent revision Obraztsov, 1960) corrected some of his mistakes. He correctly acknowledged the independence of P. clanculana Tgstr. and after Dr. Hanneman had studied the lectotype of Paedisca ravulana H.-S. he excluded the Herrick-Schaeffer name from the genus Pammene Hb., since this species was identical with Epiblema trigeminana Stph.; and restored the later name given by Rebel, R. agnotana Rbl., for one of the species in this section. On the other hand, Obraztsov was mistaken in placing P. leudersiana Sorh. in another group, in maintaining the independence of P. tomiana Z. and P. obscurana Stph., and in placing P. snellenana Bent. and P. engadinensis M.-Rutz in a group of species whose taxonomic position had not been determined.

The failure of the previous attempts of Kennel and Obraztsov, due to the inaccessibility of certain of the types, or their loss, called for an extremely cautious approach to problems concerned with synonomy, and to the literature on species in the section obscurana. After revision of all the available materials, I can state that the species that make up this group are far less diverse than was previously thought to be the case. In practice one finds four good species in the Palearctic region: P. obscurana Stph., P. agnotana Rbl., P. clanculana Tgstr. and P. luedersiana Sorh. The other names of the seven given above are clearly synonyms, although it is difficult in some cases to say exactly to which species they refer.

The moths are of a monotonous dark grayish-brown color, with an indistinct straight grayish-white dorsal spot or a washed out band in its place. The male genitalia have a poorly differentiated valva with a shallow notch on the lower margin and a rodlike penis without processes. The lateral margins of the female genital plate are not raised. Biologically the section obscurana is associated with birch (Betula) and hawthorn (Crataegus). The majority of species are concentrated in Europe; geographically this most northerly group of the genus extends to the tundra beyond the Arctic Circle and, in the mountains, to the Alpine zone.

Pammene clanculana Tgstr., bona sp.

Tengström, 1869: 362 (Grapholitha); Benander, 1928: 140-142, f. 3 (Laspeyresia phacana Wck.); Benander, 1931: 53; Valle, 1933: 216; Obraztsov, 1951: 325 (obscurana Stph., part.); Obraztsov, 1960: 117.

Moth. Wing expanse 10.5-11.5, rarely 9.5-12.5 mm. Basic color of fore wings grayish brown. An indistinct grayish dorsal spot, reaching the middle of the wing, divided by 1-3 indistinct blackish-brown lines. A washed out, grayish, slightly shining median transverse stripe extends obliquely from the pair of normally

duplicated grayish costal striae slightly forward of the middle of the fore wing. This stripe, which extends to the apex of the whitish-gray dorsal spot, is darker than the spot but lighter than the surrounding expanse. Both this stripe and the dorsal spot bound the field with a dark grayish-brown base that occupies more than a third of the wing and the edge of which is bent at an obtuse angle. The base of the dorsal spot is shifted to the apex of the wing: the distance from the dorsal spot to the base is greater than the distance from the spot to the anal angle of the wing. There are four quite distinct whitish costal striae on the apical half of the wing; the fourth stria is always double and a wide costal metallic line that extends almost directly to the anal angle, to form the shining white inner line of the speculum, originates from it. The outer line of the triangular speculum is finer and shorter, within the speculum there are 2-4 small black dots. A small grayish-white subapical stria is sometimes absent. There are variations in size, coloration and degree of definition of the dorsal spot.

The posterior wings of both sexes are uniformly grayish, the black stria is absent from the anterior margin in the male. The cilia, which are slightly lighter at the wing base, are light gray, with a darker line at their base.

Frons and palpi grayish, 3rd segment very small.

Male genitalia (Fig. 1, a, b). Valva wide, upper margin uniformly concave, lower margin with a quite sharp but shallow notch. Cucullus elongated, 2-2.5 times as long as wide, lower angle distinct, slightly acute. Valva widest in the region of the sacculus. Inner surface along lower margin of cucullus thickly covered with fine chaetae and bristles, cervical bristles a little less dense. Penis as long or slightly shorter than cucullus, slightly swollen in the middle and tapering apically, eversible part with approximately ten spines. Length and shape of cucullus variable.

Female genitalia (Fig. 2 a). Copulatory aperture is a funnel-shaped, sclerotized semicircle, the lateral margins of which are drawn backwards and appear from the ventral aspect as two raised parallel combs along the sides of the broad, practically square postvaginal plate. Genital plate long with a shallow notch on posterior margin and convexly curved lateral margins without grooves. Greater part of genital plate quite thickly covered with scales that form a wide transverse band along the anterior margin, are thickly scattered along the posterior margin, but leave two scale-free circular fields along the sides of the plate. The fine duct of the bursa is sclerotized over a considerable area in the region adjacent to the copulatory aperture; viewed ventrally this sclerotization has the appearance of a sharp tooth. The sclerites of the bursa are as large as, or larger than, the diameter of the copulatory aperture. Anal papillae quite broad, length of setae not exceeding cross section of the papillae.

Material. Collections of the Institute of Zoology (USSR Academy of sciences). 4♂♂, 3♀♀, basin of Lake Vud-Yavr, Kukisvumchorr plateau Khibiny, 14 June – 15 July 1933 (Fridolin); 2♀♀, Pay-Yer ridge, Northern Urals, 29 July-8 August 1925 (?Fridolin); 2♂♂ Petrozavodsk, 1 is probably the metatype, while the other was mistakenly identified by Gunter as "nemorivaga" Tgstr." (Gunter); 1♂, Shuvalovo, near Leningrad, 14 June 1874; 1♂, Shchush'ya River, Komi ASSR, 11 July 1928 (Samko): Norway (Polar). 2♂♂, 2♀♀, from the collections of Yershov, Romanov and Staudinger, mistakenly identified by Staudinger and al'feraki as "ravulana" H. -S." Finland (Lapland). 1♂, Vaitolakhti, 12 July 1929 (Suomalainen); 1♂

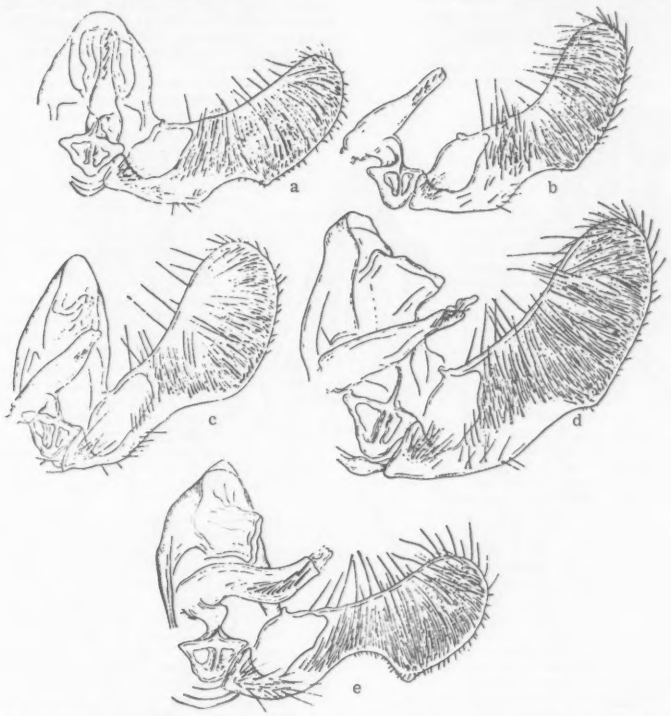

Fig. 1. - Genitalia of Pammene, ♂♂: a - P. clanculana Tgstr. (Enontekiö, Northern Finland); b - P. clanculana Tgstr. (r. Shchuch'ya, Komi ASSR); c - P. angotana Rbl. (Poznan Administrative District, Poland); d - P. obscurana (Tyrol, Austria); e - P. luedersiana Sorh. (Brussa, Turkey).

Enontekio, Khetta, 29 June 1928 (Suomalainen); 1 specimen with the label "Ounastanturit" 24 July 1951 (Kaysila).

Collections of the University Zoological Museum, Helsinki. USSR, 1 ♂, type Grapholitha clanculana Tgstr., from Tengström's collection, Petrozavodsk (Gunter).

Distribution. USSR: north of European Russia, Northern Urals. Scandinavia.

Biology. Larva lives in the catkins of Betula nana (Benander, 1928), and possibly on other birches. The moths fly from the middle of June to the beginning of August (14-June-8 August) and often come close to snow fields (Fridolin). One generation.

Comparative notes. Tengström's type (♂) sent to me by Dr. Kaysila had no abdomen and carried the following label: "Petrosaw." "Günther" "Coll. Tgstr.", "Mus. Zool. H.-fors. Spec. type No. 7134 Grapholitha clanculana Tgstr." It tallied exactly with one specimen from Gunther's collection preserved in our Institute which has a similar printed label "Petrosaw.", "Gunter" and a handwritten annotation "clanculana Tgstr."

Despite the great variability in structure, the male genitalia provide a reliable basis for distinction from P. obscurana Stph.

Pammene agnotana Rbl.

Rebel, 1914: 58; Toll. 1947:22; Van Deurs, 1956: 279, Vol. XXXI, f.8, f. 36e; Obraztsov, 1960:117.

Moth. Smaller than P. clanculana Tgstr., wing expanse 9.5-11.0 mm. Color and patterning of lower fore wings the same as on P. clanculana Tgstr. Differs in the positioning of the dorsal spot, which is shifted toward the wing base (distance from dorsal spot to wing base less than distance from spot to anal angle), less distinct costal striae, duller costal metallic lines and lines of speculum. Speculum less clearly defined than in P. clanculana Tgstr. Subapical stria usually absent. Hind wings as in P. clanculana Tgstr.

Male genitalia (Fig. 1, c) similar to P. clanculana Tgstr., but clearly distinguishable by the structure of the valva, which is much narrower basally and has a wider notch in the lower margin. This notch is very smooth and shallow. Cucullus considerably wider than sacculus, length 1.5 times width, lower angle rounded. Internal surface and neck of cucullus thickly covered by fine chetae and bristles as in P. clanculana Tgstr. Penis same shape as in P. clanculana Tgstr., but of more uniform thickness and shorter than cucullus. In the specimens studied there were five small spinules within the penis.

Female genitalia (Fig. 2, b). Sclerotized lateral margins of copulatory aperture drawn back to form two gradually converging postvaginal sclerites. Genital plate shorter than in P. clanculana Tgstr. with a shallow notch on posterior margin and depressed notches along lateral margins, almost uniformly covered in scales. Sclerotization of the duct of the bursa copulatrix forms a ring that is slightly longer than its cross section. Sclerites of bursa considerably finer than in P. clanculana Tgstr., their length is much smaller than the diameter of the copulatory aperture. Anal papillae narrower than in P. clanculana Tgstr.

Materials. Austria 1 ♂, near Vienna, 30 April, 1933 (Preisecker), identified by Amsel as "P. ravulana H.-S. (= agnotana Rbl.)" Poland. 3 ♂♂, 1 ♀, Poznan Administrative District, Roznovka, 8 April 1949, from larvae with Crataegus oxyacantha (Schmidt).

Distribution. USSR: Western Ukraine (conjectural). Denmark, West and East Germany, Poland, Austria, Hungary.

Biology. There are some biological features that distinguish this species clearly from P. clanculana Tgstr. According to Toll (1947) the caterpillar does not live on birch but beneath the bark of hawthorn (Cratageus oxyacantha). Area restricted to Central European

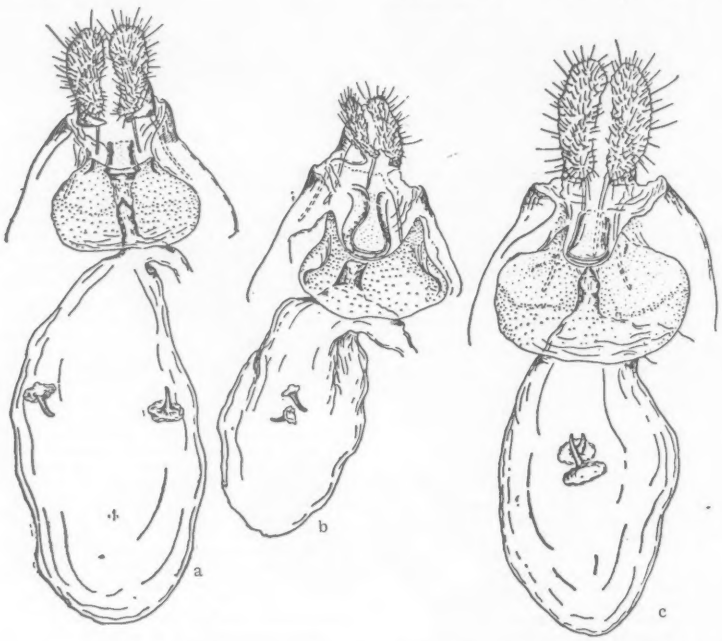

Fig. 2. - Genitalia of Pammene, ♀♀: a - P. clanculana Tgstr. (Khibiny, Murmansk region); b - P. agnotana Rbl. (Poznan Administrative District, Poland); c - P. obscurana Stph. (Leningrad).

districts. One generation.

Comparative notes. Although the type of P. agnotana Rbl. was not studied, the species here redescribed tallies with Rebel's species, both with reference to the original description and in relation to biological features. The specimens studied were reared from caterpillars on Cratageus in April and Rebel (1914) noted flight in this month and attraction to hawthorn.

Pammene obscurana Stph.

Stephens, 1834:98 (Pseudotomia); Meyrick, 1927:543, 557 (Eucosma); Pierce and Metcalfe, 1922; 90, Pl. XXXI; Van Deurs, 1956:179, Vol. XXI, f. 7, 24 k (Eucosma); Bradley, 1959:70, Pl. 4, f. 48; Obraztsov, 1960:117. – tomiana Z. Zeller, 1868: 85-86 (Grapholitha); Snellen, 1882:372; Obraztsov, 1951:321-326, f. 2; Burmann, 1952:333-339, Obraztsov, 1960:117.

Moth. Larger than P. clanculana Tgstr. Wing expanse 13.0-15.0 mm. The fore wings are wider than in P. clanculana Tgstr. The dark grayish-brown coloration and markings are as variable as in the last two species. There is a grayish-white dorsal spot with 1-3 dividing lines in the middle of the posterior margin, which is usually more pronounced and consists of pure white scales in dark specimens. The indistinct steel gray costal striae, metallic lines and lines of the speculum are dull, as in P. agnotana Rbl., and do not have the luster typical of P. clanculana Tgstr. One can usually note an indistinct grayish subapical stria. The hind wings are grayish and slightly lighter at the base, the male has a pronounced longitudinal stria consisting of black scales on the anterior margin. This is a distinguishing feature of the species that is absent from P. clanculana Tgstr. and P. agnotana Rbl. The fringe is light gray with a darker line at the base.

Male genitalia (Fig. 1, d). Valva larger than in P. clanculana Tgstr. Upper margin gently curved, lower margin with an almost imperceptible notch that does little to indicate the neck. The whole valva of P. clanculana Tgstr. is narrower than the cross section of the neck in this species. The cucullus is less extended than in P. clanculana Tgstr., its length being approximately twice its width. Lower angle of cucullus indistinct. Valva widest in vicinity of sacculus. Lower part of cucullus and neck thickly covered by fine chaetae and bristles. A bare edge along lower margin of neck near notch. Penis somewhat broader at the base than in P. clanculana Tgstr., slightly shorter than the cucullus, slightly swollen in the middle, approximately 10 spines on the eversible part.

Female genitalia (Fig. 2, c). Similar to the female sexual apparatus of P. clanculana Tgstr., except that all sclerites are considerably larger. Anal papillae longer and wider. Genital plate of same shape as in P. clanculana Tgstr., but notch on posterior margin noticeably deeper. Sclerotized margins of copulatory sperture drawn back to form a more elongated postvaginal plate. Sclerotized section of duct of bursa copulatrix same shape as in P. clanculana Tgstr., but the membranous area between the sclerotized sector and the copulatory aperture noticeably shorter.

Material. USSR. 1 ♂, October Revolution Island, Severnaya Zemlya, 15 July 1958 (Sey); 1 ♂, Petrozavodsk, mistakenly identified as "funebrana Tr." (Günter); 1 ♀, Leningrad, from Romanov's collection, 4 June 1882, mistakenly identified as L. funebrana Tr. (Heidemann); 1 ♂, Ust'-Kut, Irkutsk region, 9 June 1957 (K. Gorodskov); 1 ♀, Gor'kiy, 12 June 1936 (S. Chetverikov). Poland, 1 ♀, from Boke's collection, Wroclaw, identified by Wolf as "obscurana Stph. – tomiana Z." Austria. 1 ♀, Zemmering, Austrian Alps, 23 July 1845 (Mann); 1 ♂, 1 ♀, Umhausen, Tyrol, 1100 m, May 1952, identified by Klimeš as P. tomiana Z. (Klimeš); 1 ♀, Innsbruck, Tyrol, 5 May 1952, identified by Amsel as P. tomiana Z. (Burmann); 1 ♂, 1 ♀, United Kingdom, British Museum collection.

Distribution. USSR: locally from the polar districts to the central districts of European Russia and Siberia. United Kingdom, East and West Germany, Holland, Austria and Poland.

Biology. Caterpillar unknown. Long flight period, from early May to late July. Obraztsov (1951) noted a preference for Betula alba thickets.

Taxonomic comments. It is impossible from Stephen's brief description of obscurana to say which species he was working with. In his original description he does not note such a characteristic feature as the existence of an intense black stria on the anterior margin of the hind wings. However, Dr. Bradley of the British Museum, where the type of this species is kept, has kindly informed me that the male of P. obscurana Stph. has such a stria. Since only one species of this group is known to exist in the well studied fauna of the British Tortricidae (Bradley, 1959), I think that Obraztsov's decision (1951) to accord separate recognition to P. tomiana Z., described from Germany, is premature. When describing this species, Zeller noted the existence of a black stria on the hind wings of the male, and I therefore agree with Dr. Wolf in treating P. tomiana Z. as a more recent synonym for P. obscurana Stph.

The male from the United Kingdom that I have studied has a deeper notch on the lower margin of the valva, and the female has shorter postvaginal sclerites, but these slight differences are not differences between species.

Pammene engadinensis M.-Rutz.

Müller-Rutz, 1920:340, Vol. II, f. 7; Obraztsov, 1960:121.

Taxonomic remarks. I am grateful to Dr. Kayser for informing me that the type is absent from the Natural History Museum in Basle, where Müller-Rutz's collections are kept. The species was described from a single male from Switzerland. It is probably a synonym for one of the three preceding species. Although the presence of a black stria on the hind wings is not noted in the original description, its large size makes it most probable that it is a synonym of P. obscurana Stph.

Pammene luedersiana Sorh.

Sorhagen, 1885:284 (Steganoptycha); Kennel, 1921:703, Vol. XXIV, f. 102; Van Deurs, 1956: 282, Vol. XXXI, f. 12, 36 j; Obraztsov, 1960:116.

Moth. Wing expanse 10.0-12.0 mm. Fore wings with a concave anterior margin, apically expanded, outer margin evenly chamfered. The basic brownish-gray color of the fore wing is created by brown scales with light tips. The external and usually distinct boundary of the basal field, that occupies approximately one-third of the wing, is composed of a darker stripe that bends practically through a right angle. There is no dorsal spot, which is replaced by a broad washed out median stripe with a silvery luster, varying in color from a practically uniform leaden luster to a dull whitish luster, with 1-3 dark dividing striae, which are more apparent on the anterior and posterior margins of the wing. The median stripe originates from two pairs of whitish costal striae at the middle of the anterior margin and falls in a slight curve to the middle of the inner margin of the wing. It is followed by a brownish transverse stripe of the basic color, which originates beyond the middle of the anterior margin and widens slightly as it curves at an obtuse angle to the posterior margin of the wing in front of the anal angle, in place of an anal spot. There are usually four distinct double white, costal striae in the apical half of the anterior margin of the wing, the second and third of which are sometimes not divided. A slightly curved, wide, silver stripe, that descends ahead of the anal angle to the posterior margin of the wing to form the internal border of the speculum, originates from the 4th costal stria. The narrow metallic line that forms the outer line of the speculum is usually broken up into two striae.

There are 1-4 longitudinal black striae within the speculum. A costal metallic line that originates from the 3rd costal stria extends into a fine subapical stria that is absent from some specimens. There is a black line at the outer margin along the base of the fring facing the subapical stria. Fringe brownish-grey, shining.

Hind wings unicolorous grayish brown, fringe light, grayish with dark brownish lines at the base.

Head and palpi covered by blackish scales with white tips.

Male genitalia (Fig. 1, e). Upper margin of valva slightly curved, lower margin with a deep semicircular notch. Cucullus shorter than in P. clanculana Tgstr., with parallel margins, rounded apex, and lower angle slightly acute. Angle of sacculus smoothly rounded. Bristles and fine chaetae cover the whole inner surface of the cucullus and neck, as in P. clanculana Tgstr., this covering being thickest along the lower margin of the valva. The thick zigzag penis is basally distended and apically tapering, its diameter only slightly less than the cross section of the neck and its length approximately the same as the cucullus. Within the penis there are 20-25 quite long spines, the length of the longest of which is approximately the diameter of the penis.

Female genitalia (Fig. 3, a). The wide copulatory aperture has the appearance of a narrow sclerotized semicircle, the lateral margins of which are drawn back to form protruding and slightly converging postvaginal sclerites along the margins of the slightly sclerotized postvaginal plate. The sclerotization on the thick duct of the bursa forms a wide ring with indistinct margins. The genital plate has a small, but quite deep, semicircular notch on the posterior margin; its anterior margin is almost stright, and the lateral margins are convex. The length of the genital plate is approximately half its width. The scale-free region is drawn out into a narrow band along the posterior margin of the plate. Sclerites of bursa long. Posterior apophyses longer than anterior. Anal papillae very wide, length of setae not exceeding the diameter of the papillae.

Material. Collections of the Institute of Zoology, USSR Academy of Sciences. USSR: 2 ♂♂, 1 ♀, Triby near Poltava, 14 May 1929, 10 June 1931, (Danilevskiy); Denmark: 1 ♀ with the label "Grib, Skov, Maglemose, 15 May, 1947"; Turkey: 4 ♂♂, from Boke's collection, Brussa, May 1851, (Mann). Collections of Vienna Natural History Museum: Greece: 1 specimen, North West Macedonia, 26 April, 1500 m (Drenovskiy); 1 specimen with the label "Halle, Strange 11 May 1860".

Distribution. USSR: the Ukraine. Europe (excluding the United Kingdom and Northern Scandinavia), Turkey.

Biology. Unknown.

Comparative remarks. The presence of a distinct transverse band at the site of the dorsal spot indicates that this species has some affinity with such Tortricidae of the section splendidulana, as P. subsalvana Vl. Kuznetz., but the structure of the genitalia compells us to place it with the species of the obscurana section already redescribed.

A specimen from Denmark obtained from Dr. Wolf differed from the others in that there was a perceptible sclerotized thread on the surface of the proximal division of the bursa copulatrix (Fig. 3, b) which is most probably an individual peculiarity.

Pammene snellenana Bent.

Bentinck, 1947: 155-156; Snellen, 1882:380-381 (vernana Knaggs); Obraztsov, 1960:121, 125.

Comparative remarks. This is certainly a more recent synonym of one of the preceding species. Snellen placed it with P. obscurana Stph. (=tomiana Z.). Pierce (Bentinck, 1947) thought that there was a reliable distinction between the genital structure of this leafroller described from Holland and P. obscurana Stph. This name is most likely to be a synonym of P. clanculana Tgstr., or P. leudersiana Sorh.

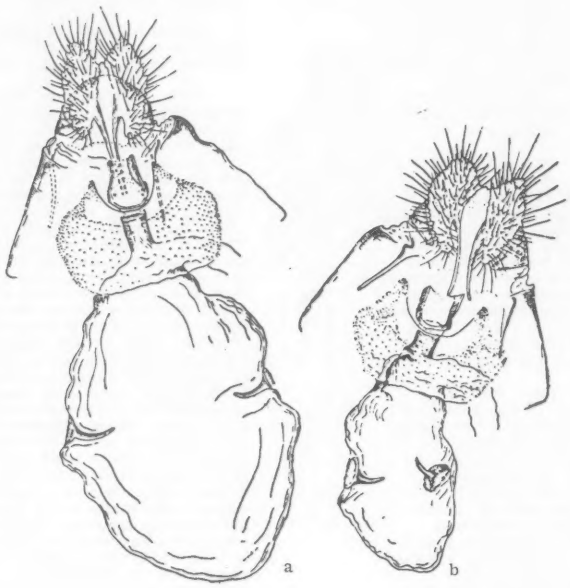

Fig. 3. - Genitalia of Pammene, ♀♀: a - P. luedersiana Sorh. (near Poltava, the Ukraine); b - P. luedersiana Sorh. (Denmark).

THE SECTION RHEDIELLA

This section embraces four species that are very difficult to distinguish by the genital structure, but the moths of which have reasonably distinct coloration: P. rhediella Cl., P. pulchella Ams., P. purpureana Const. and P. ornata Wlsgm. The fore wings, that do not have a dorsal spot, have a brownish-red apex; the hind wings of the male have a short dark stria on A_1. The cucullus of the male has its lower angle extended to form a projection; the major extent of the duct of the bursa is sclerotized in the female. Biologically this group is associated with the Rosaceae and the Ericaceae and tends geographically toward the Mediterranean.

One representative of this section — P. rhediella Cl. has been well studied. Owing to the existence of many good descriptions, drawings and photographs of the moths of P. rhediella Cl. we need only give drawings of the genitalia (Fig. 4a, 5a).

Pammene pulchella Ams.

Amsel, 1935:292, Vol. II, f. 108, Vol. XV, f. 36; Obraztsov, 1960:120 Dr. Amsel was kind enough to allow me to restudy the type of this species and to clarify its taxonomic position.

Moth. (♂). Wing expanse 10 mm. Reminiscent of P. rhediella Cl. in appearance, although the differences are very fundamental. The basic color of the basal half of the fore wing is brownish, but not unicolorous as in the case of P. rhediella, since there are inclusions of reddish-orange scales. Anterior margin of wing lighter, costal striae not pronounced. Outer margin of wing brownish-red without a dark line along the brownish-gray shining fringe. There is a broad yellow transverse field between the basal field and the outer brownish-red field. This yellow field is lighter and almost whitish at the anterior margin of the wings. There are no metallic lines, speculum and subapical stria.

Hind wings lighter at the base than in P. rhediella Cl., with a short dark stria on A_1. Fringe white with a dark line at the base.

Male genitalia (Fig. 4b) differ little from P. rhediella Cl. The spinules on the outer surface of the narrower neck of the valva are short, their length being considerably less than the diameter of the neck. There are not more than six aciculae, the longest of which is approximately one third the length of the penis, on the eversible section of the penis. In P. rhediella Cl. (Fig. 4a), the aciculate bristles on the inner surface of the neck are longer than its diameter, and there are up to ten large aciculae on the eversible section of the penis, although the largest is also one third the length of the penis.

Material. Amsel's collection. Palestine, 1 ♂, monotype, Qiryat Anavim, near Jerusalem, 28 March 1930 (Amsel).

Distribution, Palestine.

Comparative remarks. In Amsel's original description (1935) the male genitalia are somewhat schematically depicted and with slight inaccuracy, since the drawing does not show that the lower angle of the cucullus is extended as a projection. The features in the genital structure that distinguish this species, which is as yet known only from a single male, from P. rhediella Cl. are therefore minor. Nevertheless, in view of the sharp differences in coloration, I am treating it as a separate species.

Pammene purpureana Cont.

Constant, 1888:169, Vol. 4, f. 8; Kennel, 1910:229; Kennel, 1921:627, Vol. XXIII, f. 30; Obraztsov, 1960:120.

Moth. Wing expanse 10.0-11.0 mm. Fore wings apically quite pointed, anterior margin almost straight, outwardly bevelled. Basal half of fore wing unicolorous, dark-brown, with a violet-purple luster, darker than in P. rhediella Cl., nearer the apex the wing becoming gradually brownish red. The shining coloration of the base of the wing and of the broad, slightly curved median transverse stripe at the site of the dorsal spot is due to bright violet-purple scales. This stripe originates from a pair of double, scarcely noticeable, yellow costal striae a third the way along the anterior margin of the wing, and descends in a curve practically to the middle of the posterior margin. There is an area of the basic dark-brown color between the wing base and this stripe. A second narrower, violet-silver, bright, metallic line, which curves down to the anal angle, and bounds the brownish-red apex of the wing on the basal side, originates from the 4th double yellowish costal stria that lies two thirds the way along the anterior margin of the wing. The space between the median metallic stripe and this line is occupied by the base color, in which the admixture

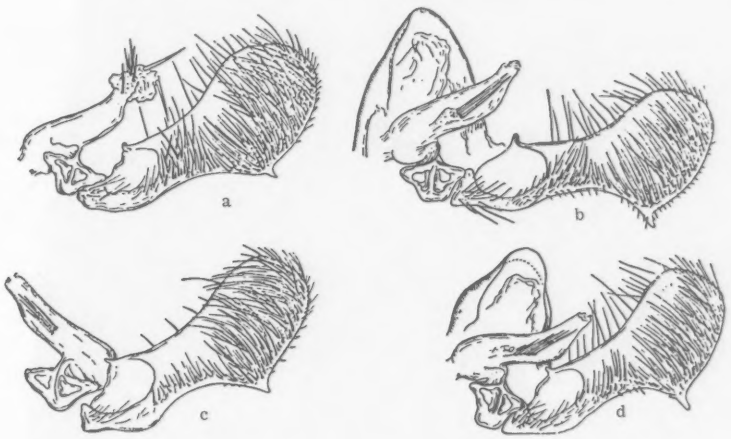

Fig. 4. - Genitalia of Pammene, ♂♂: a - P. rhediella Cl. (Silesia); b - P. pulchella Ams., monotype (near Jerusalem, Palestine); c - P. purpureana Const. (France); d - P. ornata Wlsgm. (Tangier, Morocco).

of reddish-brown scales increases toward the outer margin. There are three small yellowish costal striae between the metallic line and the apex of the wing on the anterior margin. These striae give rise to bright, silvery, costal metallic lines that extend in the direction of the outer margin of the wing. Unlike P. rhediella Cl., the speculum is scarcely outlined, since there is no silvery band along the outside (only a few silvery scales remain). A fine black line, that is sometimes broken subapically by reddish-brown scales, extends along the outer margin. There is no subapical stria. The fringe is brownish and shining.

The hind wings are darker than in P. rhediella Cl., dark brown, almost unicolorous in the female, with a slightly darkened apex, and a short blackish stria on A_1 in the male. Fringe brownish yellow, with a dark line along the base of the same shade as the base color of the wing.

Head and palpi grayish brown, the similarly colored dorsum and tegulae with a violet sheen.

Male genitalia (Fig. 4 c). The valva and penis are very similar in structure to those of P. rhediella Cl. (Fig. 4a) although the upper margin of the valva is more curved and the shape of the cucullus is slightly different. There 2-4 aciculae on the eversible part of the penis, which are longer than the diameter of the neck of the valva, whereas P. rhediella has up to 10 short aciculae.

Female genitalia (Fig. 5b). Only slight differences from P. rhediella Cl. (Fig. 5a); the sclerotized funnel of the copulatory aperture forms a wider semicircle, lateral margins of genital plate protruding rather than level and straight, areas along the margins of the genital plate in which the sparsely scattered scales are somewhat differently distributed, postvaginal plate somewhat shorter, sclerites of bursa smaller.

Materials. France: 1 ♂, 1 ♀, from Staudinger's collection, 1890, 1 ♂, Cannes. Collector and date not indicated.

Distribution. France.

Biology. In May and June the caterpillars live in the internal channel at the crown of still unlignified shoots of strawberry tree branches (Arbutus unedo), from which they sometimes emerge at the surface, bringing interwoven young leaves to the outlet aperture (Constant, 1888). They sometimes forsake the shoot and penetrate into a ripe fruit. A high mortality rate is observed in leaf feeding. They pupate in quite compact ovoid cocoons on the branches where they apparently overwinter. The biology of the species clearly distinguishes it from P. rhediella Cl., since the caterpillars of P. rhediella Cl. live mainly in the fruits of Rosaceae.

Pammene ornata, Wlsgm.,

Walsingham, 1903:212-213; Obraztsov, 1960:120.

My examination of paratypes of this species, kindly made available by Dr. Bradley, supported the correctness of Walsingham's opinion (1903) that this species is very close to the previous species.

Moth. Wing expanse 9.5-11.0 mm. Shape of fore wing, basic coloration, shade and position of 1st and 2nd bright violet transverse stripes and black marginal line along the outer margin as in P. purpureana Const.

Differs from P. purpureana in that the basal field is a unicolorous dark brown in the area from the base of the wing to the median bright violet stripe, in having indistinct costal striae and the same distinct, short, bright silver outer line of the speculum as P. rhediella Cl.

The color of the hind wings is very typical in both sexes. The wing of the female is greatly lightened at the base, light yellow, with a dark brownish apex and an irregular, quite wide brownish stripe along the lower and inner margins. The wing of the male is an even lighter, whitish yellow with an intensely brown apex and a fine stripe along the inner margin. The dark brown color is very sharply distinguished from the basic whitish yellow. There is the same short blackish stria on A_1 as in P. purpureana Const., but it is on a light-yellow ground. The fringe is brownish yellow as in P. purpureana Const., but the dividing line at its base is yellowish and scarcely distinguishable in color from the fringe, except that it is slightly darkened at the apex.

Head, palpi, dorsum and tegulae grayish brown, as in P. purpureana Const.

Male genitalia (Fig. 4d). The same as in

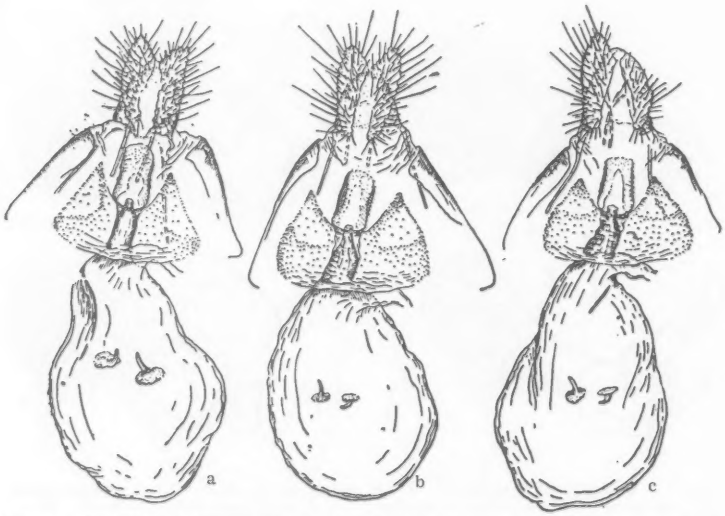

Fig. 5. - Genitalia of Pammene, ♀♀: a - P. rhediella Cl. (Silesia); b - P. purpureana Const. (France); c - P. ornata Wlsgm., paratype (Tangier, Morocco).

P. purpureana Const., except that the fine chaetae on the inner surface of the neck are shorter.

Female genitalia (Fig. 5c). Postvaginal plate somewhat shorter and genital plate shorter than in P. purpureana Const. No other differences discovered.

Material. Morocco, 1 ♂, 1 ♀, paratypes, from Walsingham's collection, Tangier, 6 March 1902 (Walsingham).

Distribution. Morocco.

Biology. The moths fly in March in strawberry tree thickets (Arbutus unedo) (Walsingham, 1903).

Comparative remarks. Despite the almost total similarity in genital structure in both sexes, and despite the probable identical specialization of the caterpillars, I have not decided to combine this species with the previous species, because there are clear differences in the coloring of the moths. These differences are stable (Walsingham, 1903), since the species has been described from a considerable series of specimens. At the very least P. ornata Wlsgm. is a good African subspecies of P. purpureana Const.

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TAXONOMY AND DEVELOPMENT OF ENDOCHIRONOMUS ALBIPENNIS MG., E. TENDENS F. AND E. IMPAR WALK (DIPTERA, TENDIPEDIDAE)

N. S. KALUGINA

Hydrobiologists constantly report the larvae of tendipedids of the genus Endochironomus Kieff. from palearctic fresh waters. They are very plentiful in some waters, and may rapidly colonize the shores of newly created reservoirs. Their profusion and large body size make them a considerable part of the littoral fauna of reservoirs, and especially of the coastal macrophytic fauna. The metamorphosis of several of the commonest species is unknown. Even the imaginal taxonomy is not absolutely clear, and the confusion that exists is amazing for such a small genus. I ran into considerable difficulties when attempting to identify the images of species from the Uchinsk reservoir (Moscow region), especially from Goetghebuer's identification keys (1937). Other authors (Brundin, 1949; Hennig, 1950; and Thienemann, 1954) have commented on the difficulty of identifying the imago, pupa and larva of this genus.

Taxonomic work on the genus is complicated by the large and confusing number of synonyms for some species. Of the 41 species of Endochironomus described for the Old World, 26 have been described by Kieffer, whose occasional carelessness in describing species is well known. Goetghebuer's monograph on the palaerctic tendipedids (1937) recognizes only 10 true species, only 2 of which are Kieffer's species. Goetghebuer classifies 17 species as synonyms and lists 9 as insufficiently known. The reduction of the many "species" of Endochironomus to synonyms, begun by Goetghebuer was very valuable. Only this will enable us to use the literature on the biology, distribution and development of a number of Endochironomus "Species", the true classification of which remains essentially unknown to this day. Unfortunately, one cannot accept Goetghebuer's lists of synonyms without qualification. Thus, Thienemann (1954) has pointed out that the pupae that Goetghebuer identified as Endochironomus tendens F. belonged to different groups.[1] My research has shown that some of the synonyms that Goetghebuer ascribes to this species belong to the "signaticornis" larval and pupal group, while others belong to the "nymphoides" group. Goetghebuer's description of the species is also sometimes in contradiction with this first regrouping of the synonyms.

Nor can one agree with Thienemann (1954) whose synonyms are based solely on larval and pupal similarities. Thus, Thienemann takes all species whose larvae and pupae belong to the "nymphoides" group as synonyms of E. tendens. Such methods can only increase the confusion. In taxonomy one must always take the structure of the imago into account. More than one species is certainly involved in the "nymphoides" group. Suffice it to mention that E. stackelbergi Goet., the metamorphosis of which has been described by A.I.Shilova (1952), could also be assigned to the "nymphoides" group on the basis of larval and pupal structure.

The metamorphosis and biology of five Endochironomus species have been described by Gripekoven (1914), but none of these species is now recognized and the actual identity of his species is unknown. In his summary of the larvae of the Diptera, Hennig (1950) states, concerning the metamorphosis of Endochironomus species, that the genus is in great need of revision, since some of the names accepted by Gripekoven are unclear in Goetghebuer or taken to be synonyms (p. 248).

Data on the metamorphosis of the American species have been given by Johannsen (1937) and Roback (1957).

Four Endochironomus species from the Amur basin have been described by Shilova (1952), who has also described the metamorphosis of E. stackelbergi Goet.

Hydrobiologists divide the genus Endochironomus into groups of species by larval and pupal structure. Lenz (1921, 1955 and 1957) described the "nymphoides" and "signaticornis" groups, and indicated which species belonged to them. The majority of these species are reduced to synonyms or taken to be insufficiently known. Lenz divides the genus Endochironomus into two subgenera (Endochironomus s. str. and Endotendipes Lenz, 1955) by larval and pupal structure. His first subgenus consists of species from the "nymphoides" and "signaticornis" groups, while the second consists of species, the larvae and pupae of which are similar to those of E. dispar Mg., the metamorphosis of which has been described by Goetghebuer (1912). Lenz places the species E. abranchius, Kieff. and E. intextus Walk., for which he has described the metamorphosis (Lenz, 1955 and 1957), in the subgenus Endotendipes.

METHOD AND MATERIAL

The species involved in the present study were identified from the imago, using the identification keys and descriptions of Edwards (1929), Goetghebuer (1937) and Coe (1950). My descriptions of the imago are closer to those of Edwards than to those of Goetghebuer. In my opinion Edwards' key for the identification of Endochironomus is better than Goetghebuer's key. When identifying species I therefore turned first to Edwards and Coe, but since they were concerned solely with British tendipedids I have deemed it essential to indicate how my specimens might be identified in Goetghebuer's key (1937). I also indicate the differences between my descriptions and those of Goetghebuer.

I make use of the information on synonyms given by Edwards and Goetghebuer, who had the opportunity of studying the types of a number of species. Nevertheless Goetghebuer's synonyms for Endochironomus cannot be accepted without qualification. It is impossible to correct the synonyms by comparing the original descriptions; many descriptions are too short and unaccompanied by drawings, and many fail to mention the characters essential to diagnosis; in addition, a number of species are described only from the female. In order to check the synonyms of the species being studied I examined all the literature pertaining to the metamorphosis and biology of the species given as synonymous. One cannot, of course, treat species as being synonymous solely on the basis of similarity in the early stages of metamorphosis, as is done by Thienemann, although data on metamorphosis is often very useful when correcting synonyms. Thus, species that have a very similar imago and are therefore often confused, may have distinctly different larvae and pupae. This is clearly shown by two of the species that I studied – E. albipennis Mg. and E. tendens F. I have excluded from the lists of synonyms given by Edwards and Goetghebuer those species which, according to reliable references, have different larvae or pupae. I have also rejected those species for which the imago appears, from

[1] For the different groups of species of the genus Endochironomus, see page 515.

the original description, to differ fundamentally from the species under consideration.

This sifting of doubtful synonyms will avoid the danger of ascribing to a species biological data given in the literature under these "synonyms" which do not apply to it. It is interesting that the larvae of all species that I have excluded from the synonyms of E. tendens on the basis of dissimilarity in larval or pupal structure are stated in the literature to have a biology that differs from this species. Moreover, the larvae of "species" that I have included as synonyms have a biology similar to that of the given species. This confirms my opinion that my corrections to the synonyms are well founded.

I used variational statistics to arrive at dimensional criteria for distinguishing between the males of E. albipennis and E. tendens. Dimensional indices were derived from measurements of various parts of the body and the reliability factor was calculated for each character. This yielded a dimensional index from which the males of these two species can be better distinguished than by the L. R. index (leg ratio — the ratio of the length of the first metatarsal segment to the length of the tibia). The new index is the ratio of the length of the first metatarsal segment to the width of the scutellum; this index is called Mt. S. R. (metatarsus-scutellum ratio). The L. R. and Mt. S. R. indices were calculated from measurements of 137 males.

In describing color I have, where necessary, given a symbol by which the shade can be identified in Bondartsev's color chart (1954) and in Ridgeway's standard color chart (1912). The first chart is indicated by the abbreviation "B" and the second by "R".

The color of the pupae is not described, since there is initially very little difference in color between the adult larva and the pupa, and its subsequent coloration is due to the coloration of the imago appearing through the coverings. I therefore only describe the color of the shed pupal exuviae.

The color of the imago is described from fresh specimens. Green is the color most common in dry species: it gradually turns yellow in very dry material.

Only the 1st and 4th larval stages are described in detail for the different larval types (Kalugina, 1959). For the 2nd and 3rd larval stages, only those characters that distinguish larvae of these stages from the adult larva have been indicated for each morphological type.

The material was collected in the Uchinsk reservoir (Moscow region). In order to identify all stages in metamorphosis, specimens were reared from eggs. Eggs were obtained in the laboratory from fertilized females that had been caught, and the development of the ecloded larvae was observed. Some larvae from each instar and the cast larval exuviae were mounted. The larvae were kept separate prior to pupation. The larval and pupal exuviae, and the midges that emerged from the pupae, were all given the same classificatory number. A series of males and females were raised from each batch of eggs. The largest series obtained from one batch were 12 images from a batch of E. albipennis Mg. eggs (10 ♂♂, and 2 ♀♀), 9 from a batch of E. tendens F. (5 ♂♂, 4 ♀♀) and 22 from a batch of E. impar Walk. (12 ♂♂, ♀♀). Adults were also reared from larvae collected under natural conditions, 62 specimens being obtained. In addition, adults were collected in the field, and we took seasonal samples of larvae and pupae.

The collections of the Zoological Institute (USSR Academy of Sciences) were used in the taxonomic work. I should like to take this opportunity of thanking A. A. Shtakelberg for allowing me to study these collections, and for his valuable advice in the preparation of this paper.

DIVISION OF THE GENUS INTO LARVAL AND PUPAL GROUPS OF SPECIES

There is no consensus of opinion on division of the genus into larval and pupal groups of species and on the group to which each species belongs. There is great confusion over the whole question. The synonyms for the names of the groups are given here, and I state which species can be ascribed to these groups on the basis of larval and pupal structure and give the morphological characters of the larvae and pupae of these groups.

I. The group "nymphoides" (Lenz, 1921, 1955) [= the group "tendens" (Chernovskiy, 1949); E. tendens Thienemann, 1954 (nec F.)].

This includes:[2] E. stackelbergi Goet. (metamorphosis: A. I. Shilova, 1952) and E. albipennis Mg. (I describe the metamorphosis in this paper).

Larva. Submentum has a bilobed median tooth, the base of which lies on the same level as the bases[3] of the remaining teeth. If the 2nd lateral teeth of the submentum are below the 3rd they are very small; they are usually as high or slightly higher than the 3rd. Pupa. A whorl of short dark bristles at the apical end of each blade of the anal fin. The entire outer margin of the anal fin is covered with long transparent bristles.

II. The group "signaticornis" (Lenz, 1921, 1955) [= the group "signaticornis" (Chernovskiy, 1949)].

This includes E. tendens F. (metamorphosis: Goetghebuer, 1912).

Larva. Submentum has one simple median tooth. Pupa. A whorl of short dark flat bristles at the apical end of each blade of the anal fin. The anterior 3/5 of the outer margin of each lobe is covered by long transparent bristles and the posterior 2/5 by short dark flat bristles.

III. The group "dispar" (Chernovskiy, 1949) [= the subgenus "Endotendipes" (Lenz, 1955)].

This includes: E. dispar Mg. (metamorphosis: Goetghebuer, 1912), E. abranchius Kieff., E. intextus Walk. (metamorphosis: Lenz, 1955) and E. impar Walk. (metamorphosis described in the present paper).

Larva. Submentum has a bilobed median tooth, the base of which is somewhat distal to the bases of the lateral teeth. Second lateral teeth of submentum considerably lower than 3rd. Pupa. Whorls of bristles absent from apical ends of lobes of anal fin. Outer margin of anal fin completely covered by long transparent bristles.

The species tendens is not, therefore, part of the group given this name in Chernovskiy's key (1949). Chernovskiy apparently described the "tendens" group from the larvae of E. albipennis and the midges that ecloded were incorrectly identified as "tendens". Chernovskiy used Goetghebuer's keys (1928, 1937), in which females and light males of E. albipennis are erroneously identified as tendens.

The species nymphoides and signaticornis from which Lenz named the first two groups are not independent species. Therefore, in accordance with the rules of zoological nomenclature, the first group should be named after the species stackelbergi and the second after the species tendens. To do so, would, however, lead to confusion in hydrobiological and ichthyological literature, since the Chernovskiy key uses "tendens" for the first group and this name has since been used frequently by hydrobiologists.

[2] I only give the group for those species that are accepted as true and sufficiently well known (Goetghebuer, 1937).

[3] The base of the tooth is the point at which the tooth grows into the adjacent teeth. The size or length of the tooth is the distance from base to vertex. The height of the tooth is the position of the vertex relative to the verticles of the adjacent teeth; when, for example, we state that the 2nd teeth are lower than the 3rd we mean that the verticles of the 2nd teeth are proximal to the verticles of the 3rd teeth.

I therefore propose that the old names of the groups be retained for the present.

I do not consider it expedient to subdivide the genus Endochironomus into two subgenera by larval and pupal structure. There is no sense in contrasting the "nymphoides" and "signaticornis" groups with the "dispar" group, since the first two groups differ as greatly between themselves as they do from the third group. Nor is it necessary to place the "dispar" group in a special subgenus on the basis of imaginal structure.

One cannot accept the grouping of species given by Thienemann (1954). As has already been indicated, Thienemann suppresses all species of the "nymphoides" pupal type as synonyms of E. tendens, and assigns all remaining species, including even E. dispar Mg., to the "signaticornis" group.

GENUS ENDOCHIRONOMUS Kieff. 1918

Kieffer, 1918, Ann. Mus. Nat. Hungar., XVI: 69.

Egg mass (Fig. 1). Egg mass cylindrical. The strings of eggs run parallel to the surface of the batch, and describe incomplete rings; i. e., having nearly completed a ring, they turn back to form a U-shaped loop. The rings are of unequal size, and quite haphazardly distributed, so that it is quite difficult to trace the form of the string of eggs. The eggs in the string are perpendicular to the surface on which the batch is deposited. Lateral branching processes extend from a fibrous mucilaginous thread of different consistency from that extending along the central axis. The mucilage of the egg mass is quite loose and mobile, and very sticky at the ends. The egg mass is attached to the substrate by both adhesive ends to form an "arch" (Fig. 1, 1). The outer mucilage of the egg mass may be formed into a single lump that contains a horseshoe-shaped group of eggs. The eggs may sometimes form a double curve inside the mucilage (Fig. 1, 4).

1st larval instar (Fig. 2). There are two fine bristles of approximately equal length on each of the 1st-7th abdominal segments. The longest bristle is approximately equal in length to the width of the abdomen. The eyes have the same shape as in the 4th instar, but are farther from each other and from the bases of the maxillae than in adult larvae (D). The antennae (A) are 5-segmented; the antennal index is not more than 0.37. The mandible (B) has 1 internal and 4 external teeth; the internal tooth lies above the distal external tooth. There is a quite wide triple tooth in the middle of the submentum (C). Its length does not exceed its width and it is approximately twice as wide as the 1st lateral tooth. The lateral lobes of the medial tooth are somewhat narrower than the median lobe, and clearly separated; dark stripes running laterally backwards from the median lobe give it the appearance of a long and distinct tooth, widening to the rear and somewhat darker in color than the remaining teeth of the submentum. There are 6 lateral teeth on each side, and they become uniformly smaller toward the side of the submentum. Brown stripes extending backward from the bases of the submental teeth together form a dark band proximal to the toothed margin of the submentum.

4th larval instar (Fig. 3). Body well-proportioned, 13-segmented thoracic segments somewhat thicker than abdomen. Parapodia conical, longer than the segments that carry them. Head oval. Frontal sclerite lanceolate, extending practically to the posterior margin of the head. Anterior margin straight. Eyes on side of head (A) close together at bases of maxillae (dotted line). Antennae (C) less than half the length of the head, seated directly on the head capsule, 5-segmented, 2 lauterborn's organs at the distal end of second segment. 1st antennal segment straight; annular organ near the base. Epipharyngeal comb (D) with 3 or 5 groups of teeth; each group consisting of 1 large median tooth, one or two smaller lateral teeth and a large number of small denticles surrounding the large teeth laterally and basally. Premandible with 2 apical teeth (B). Five external dark teeth on mandible (E), the proximal of which is fused with the base of the mandible, or not fully separated from it; and 1 yellow internal tooth, the apex of which lies at approximately the same level as the apex of

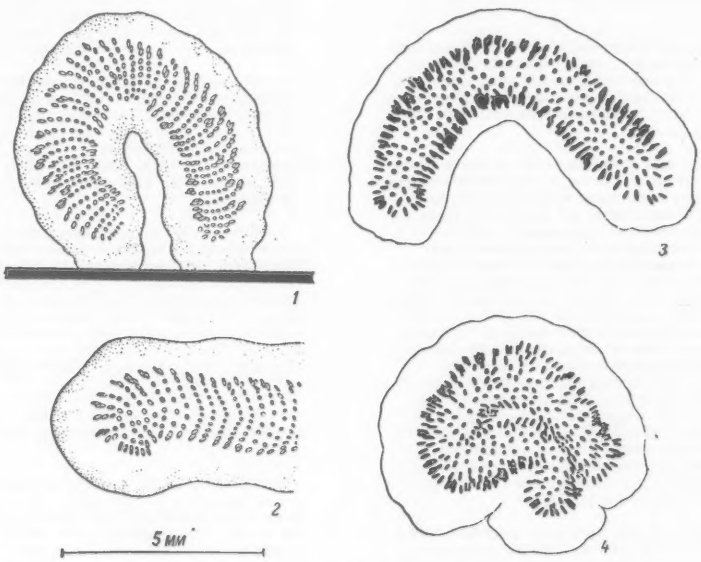

Fig. 1. - Egg masses: 1 - egg mass of Endochironomus albipennis Mg. attached to substrate; 2 - half of egg mass of E. tendens F.; 3 and 4 - from retouched photographs of egg masses of E. impar Walk.

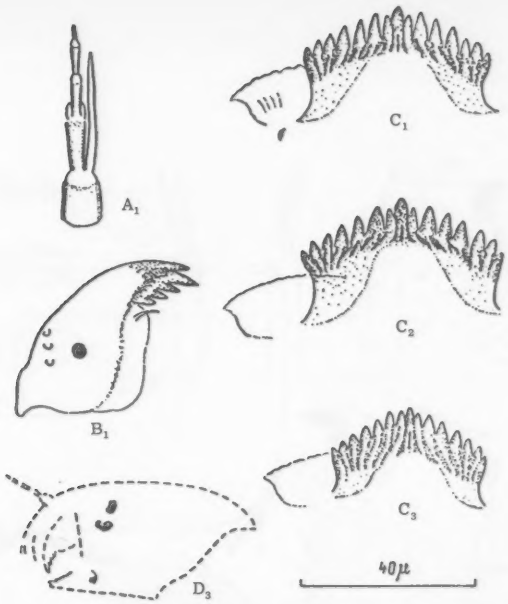

Fig. 2. - Structural details of first larval instar. A - antenna; B - mandible; C - submentum; D - eyes: A_1-C_1 - Endochironomus albipennis Mg.; C_2-E. tendens F.; C_3-D_3 - E. impar. Walk.

the 2nd external tooth. Sword-shaped seta narrow and curved. Proximal to it on the margin of the mandible there is a light tooth, the point of which faces the distal end of the mandible. The margin of the submentum (F) turns forward in a long slightly curved arc. One or two median teeth, 7 lateral teeth on each side, irregularly decreasing in size towards the sides of the submentum: 2nd and 5th teeth markedly smaller, sometimes shorter than 3rd and 6th. Paralabial submental plates narrow, transverse; index[4] not more than 3. Inner angles of plates acute, widely gaping, external angles obtuse, wide, curving to the base of the head, and terminating in a sharp bull-like tooth. Striation of plates radial and close; very fine rounded denticles on anterior margin.

Pupa (Fig. 4). Abdominal tergite II terminating behind in a broad projection bearing a continuous row of marginal hooklets (A). Hooklets massive, dark, with sharp apex curving upwards and forward, and a sharp tooth on the convex posterior angle. Surface of tergites and sternites on the majority of the abdominal segments plentifully covered with fine spines, usually called "shagreening" in tendipedids. The largest and darkest spines on tergites 2-6 are anteriorly thickened to form a narrow dark band. The shagreening of the tergites is broken by many circular areas free of spines (A). Shagreening on the sternites and posterior tergites consists typically of very small spinules that are hard to see at low magnifications; these spinules are often arranged in groups, but some form rows (B). A yellow or brown stripe that runs along the sides of the abdominal segment widens toward the anal-lateral angles of the 8th segment. These angles each carry a wide ridge of sharp conical teeth (C). The nature of the short hairs on the external margins of the anal fin is of importance in identification (C).

Imago (Fig. 5). Palpi 4-segmented. Antennae ♂ 14-segmented, ♀ 7-segmented. Eyes protruding above scapes in long, straight inwardly pointing projections. Frontal tubercles absent. Pronotum well developed, dorsal half tapering apically. When the specimen is viewed from the dorsal or anterodorsal aspect the free dorsal margin of the pronotum, divided by a deep medial notch into two lobes, can be seen above the anterodorsal margin of the mesonotum. This notch extends to the point where the pronotum fuses with the mesonotum. There are scales bearing several long thick bristles and sometimes an apical spur at the distal end of the fore tibia (B). The middle and hind tibiae have at the distal end, two combs, each with a spur. If the combs coalesce, the outer spur is reduced in size, or disappears (C and D). Pulvillae broad and conspicuous. No spots on wings; rm not darker than c, r_1 and r_{4+5}; r_{2+3} clearly separated from r_1; the distance between them increasing gradually toward the end, since r_1 curves steeply toward c, while r_{2+3} is straighter; fcu is slightly farther from the base of the wing than rm. Hypopygium (A) has 3 pairs of appendages. Gonostyles large and oval; the hooks comprising the 1st pair of appendages extend approximately to the middle of the aedeagus and only bear bristles basally. Aedeagus extends considerably beyond the end of the spine on the dorsal plate, and is 1/3-1/4 the width of the gonostyles; distal half covered with antrorse bristles and with 2-3 long apical bristles.

Taxonomic comments. These are the first genetic descriptions of the eggs and 1st larval instar. There are generic descriptions of the 4th larval instar and pupae of Endochironomus in Gripekoven (1914), Johannsen (1937), Shilova (1952) and Lenz (1957). My descriptions are expanded; they take into account the structure of

[4]The paralabial plate index is the ratio of the internal and external angles of the plate to the distance between the anterior and posterior margins of the plate in the middle.

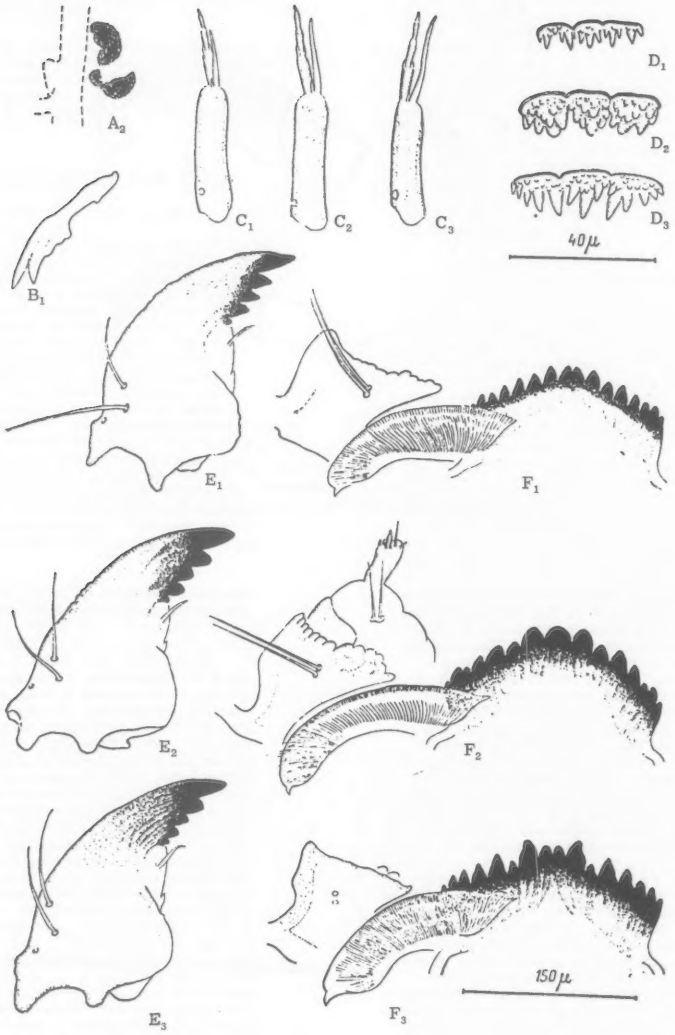

Fig. 3. - Structural details of fourth larval instar: A - eyes at base of maxillae; B - premandible; C - antenna; D - epipharyngeal comb; E - mandible; F - submentum and paralabial plate and base of maxilla. B_1-F_1 - Endochironomous albipennis Mg.; A_2, C_2 - F_2 - E. tendens F.; C_3 - F_3 - E. impar Walk.

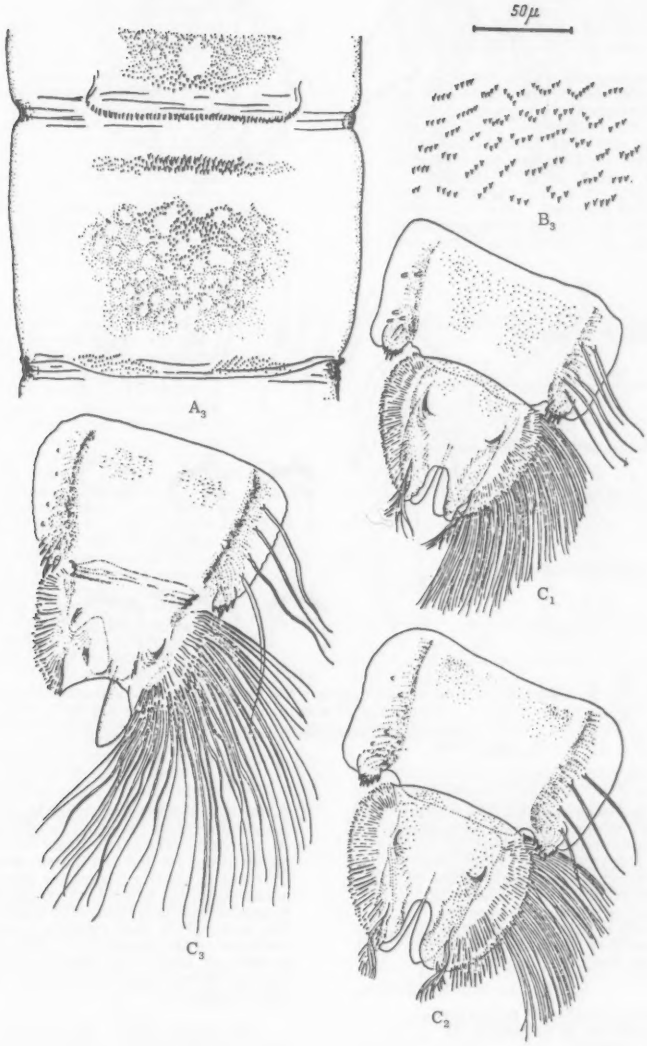

Fig. 4. - Details of pupal structure: A - shagreening of 2nd-3rd tergites, B - shagreening of 7th tergite highly magnified, C-8th tergite and anal fin (♂), C_1 - Endochironomus albipennis Mg.; C_2 - E. tendens F.; A_3-C_3 - E. impar Walk.

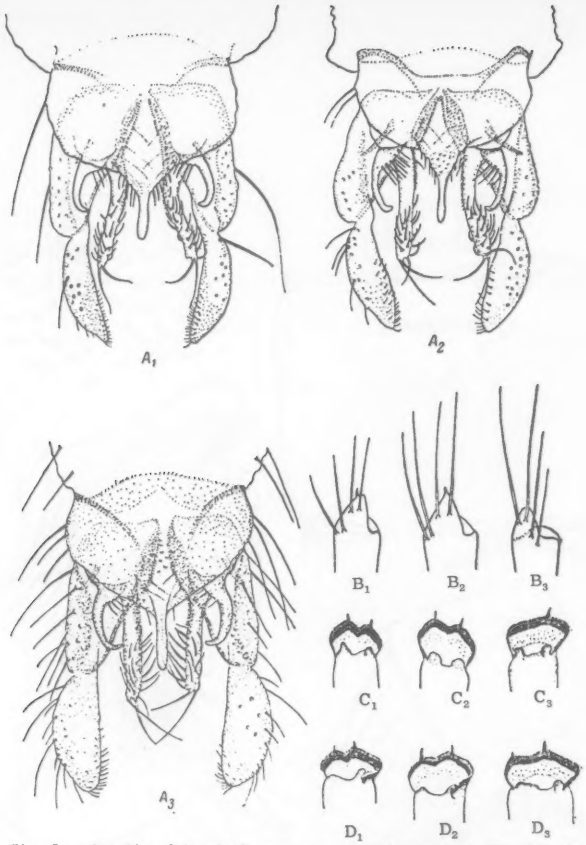

Fig. 5. - Details of imaginal structure: A - hypopygium, B - distal end of fore tibia, C - distal end of middle tibia, D - distal end of hind tibia. A_1-D_1 - Endochironomus albipennis Mg.; A_2-D_2 - E. tendens F.; A_3-D_3 - E. impar Walk.

specimens of all three larval and pupal groups. Particular attention is paid to generic characters. My generic description of the imago differs somewhat from that given by Edwards (1929), Goetghebuer (1937) and Coe (1950). According to my description the spurs on the combs of the middle and hind tibiae need not necessarily be absent or greatly reduced: this is usually only the case when the combs coalesce. Coalescence of the combs has been observed. The distal end of the fore tibia, the hypopygium and the venation of the wing are described in greater detail.

The generic descriptions given here are provisional. They may possibly be slightly altered or expanded, as other species of the genus are studied.

ENDOCHIRONOMUS ALBIPENNIS Mg., 1830

Meigen, 1830, Syst. Beschr., VI: 248, 87.

Syn. ? miki Kieff.

Egg mass (Fig. 1, 1). Structure typical of the genus. Color of eggs pale lemon-yellow (B: ∞ 1 3; R: V 25 d).

1st larval instar (Fig. 2, A_1-C_1). Colorless, up to 1 mm long. Antennal index 0.33 (0.22-0.37), length of scape 11 μ, bristle terminating in the distal half of the 4th segment (A_1). Color of mandibular teeth (B_1) and submental teeth (C_1) brown. The stripes that run from the bases of the 1st and 2nd lateral submental teeth (C_1) curve slightly toward the sides of the submentum; the width of the band that they form is approximately 1.5 times the length of these teeth. The width of the band increases slightly toward the sides of the submentum. The median tooth is twice as long as the distance between the level of its base and the posterior margin of the band beneath it.

2nd larval instar. Similar in structure to the 4th larval instar. Body length up to 3 mm; color pale green. Average length and width of head 190 μ. Antennal index 0.84 (0.80-0.91), length of scape 33 (30-37) μ; bristle ends between distal third of 4th antennal segment and proximal half of 5th antennal segment. Paralabial plate index 3.10 (3.00-3.12).

3rd larval instar. Similar to 4th larval instar in structure. Body length up to 5.5 mm, color greenish yellow. Average length of head 353 μ, width — 323 μ. Antennal index 1.11 (1.07-1.15), length of scape 60 (57-65) μ, bristle terminates between distal half of 4th segment and proximal half of 5th segment. Anterior margin of base of maxilla slightly

undulating. Paralabial plate index 3.78 (3.33-4.00).

4th larval instar. (Fig. 3, B_1-F_1). Length of body up to 11 mm, color of adult larva yellowish orange (B: d2; R:III 17d) to orange (B: o 3; R: III 15, Orange). Head capsule transparent, light yellow, contents of head give it the same color as the body. Average width of head 551 μ, length 646 μ. Antennal index 1.50 (1.36-1.67), length of scape 115 (100-122) μ, bristle terminating between 3rd and 4th segments (C_1). Epipharyngeal comb (D_1) consisting of 5 groups of teeth. Mandibles (E_1) have 5 external teeth, 4 of which are dark brown true teeth, and 1 of which is a yellow or light brown false tooth. There are several large rounded teeth on the anterior margin at the base of the maxillae (F_1) near the medial margin. Medial submental tooth (F_1) double, its base in the same arc with the bases of the remaining teeth; 1st lateral teeth somewhat longer and higher than the medial teeth, or the same size; remaining teeth decreasing quite uniformly towards the sides of the submentum; 2nd and 5th teeth slightly shorter than 3rd and 6th, and approximately equal to them in height; 7th teeth small and considerably lower than 6th. Paralabial plate index 4.41(4.17-4.42).

Pupa (Fig. 4, C_1). Length 7-10 mm. Exuviae transparent, pale yellow (B: p 3; R: XXX 19'-b). Shagreening of yellow spines on 2nd-7th abdominal tergites. Size of spines varies: the largest and darkest form a narrow band along the anterior margin of the 2nd-6th tergites; spinules of medium size scattered on posterior parts of 2nd – 6th tergites, and anterior portion of 7th tergite; small spinules cover the center of the 2nd–6th tergites. No shagreening on posterior third of 7th tergite. Several large, light yellow spines with broad bases and sharp antrorse apices located in the intersegmental folds of the 4th-5th, 5th-6th and 6th-7th tergites. Shagreening of very fine spinules arranged in short rows anteriorly on 8th tergite, tergite of anal fine, and 7th-8th sternites. 2nd-3rd sternites shagreened with similar spinules seated separately; 2nd sternite almost totally, 3rd sternite only laterally, shagreened. No shagreening on remaining sternites. 1-5 long marginal bristles on 7th-8th segments, remaining marginal bristles short and fine. Teeth of anal – lateral combs of 8th segment (C_1) yellow (B: d 2; R: XV 17' b). Arc of comb slanting, not reaching lateral margin of segment. 6 – 9 teeth in each comb; 3rd - 5th of approximately the same size and larger than the others. External margin of anal fine (C_1) covered in long, soft, transparent bristles with darkened bases. Largest bristles slightly shorter than anal fine. A whorl of flat, dark bristles at the apical angle of each blade of the fine. Lobes of male sexual appendages reach the posterior margin of the fine, but in the female fall short of it by approximately its length.

Imago (Fig. 5, A_1-D_1). ♂. Basic body color (due to the contents of the body showing through) yellowish green (B : e 7 – and 2; R: XVII 24' Apple Green). Head color yellowish green to brown. Funiculus and mouth parts brown to blackish brown. Scapes, mesonotal bands, postnotum and mesosternum vary from reddish yellow (B; zh 2; R: XV 15', Ochraceous Orange) to dark brown (B: O 7; R; XXVIII 7 " m). Scutellum yellowish green to yellow. Episterna yellow to reddish yellow. Legs pale yellow. Ultimate or ultimate and penultimate tarsal segments brown. Scales on distal end of fore tibia (B_1) terminate in a spur slightly to the side of the apical end of the scales. Distal ends of middle and hind tibiae with 2 brown combs, each of which has a spur; internal spur equal in length to, or slightly shorter than, external spur; a distinct boundary between combs (C_1-D_1). Fore tibia and proximal sector of hind metatarsus covered in very fine appressed hairs; distal half (or distal 3/5) of fore metatarsus with a fringe of long hairs (Fig. 6, A). Transition from short hairs of anterior sector to long hairs of fringe distinct. Fringe hairs approximately equal in length to the hairy covering on the middle and hind tibiae. The length of the fringe hairs declines gradually towards the distal end of the tarsus and the fringe disappears by the end of the 3rd segment. L. R. -1.14 (1.03-1.20); Mt. S. R. -3.29 (2.91-3.87). Wings transparent, colorless with a slight milky tinge; length of wing 4.05 (3.50-4.75) mm, width 1.01 (0.90-1.25) mm. Halteres colorless or slightly greenish. Abdomen yellowish green. Hypopygium (A_1) yellow. The bristle-free proximal part of the aedeagus shorter than the covered distal sector by approximately 1/5 the length of the aedeagus. Length of body (without antennae) 6.35 (5.50-7.50) mm.

♀. Basic body color yellowish green. Antennae light yellow to reddish-yellow. Mesonotal bands, postnotum and mesosternum varying from greenish yellow (B: and 1; R: XVII 25' b) to reddish yellow. Four legs uniformly covered with short appressed hairs, no fringes. (L. R. - 1.08 (1.02-1.18); Mt. S. R. - 3.12 (2.95-3.35). Length of wings 4.49 (4. 25-4.75) mm, width 1.21 (1.00-1.35) mm. Abdomen yellowish green. Remaining parts have same color as in male. Body length 4.72 (3.25-5.50) mm.

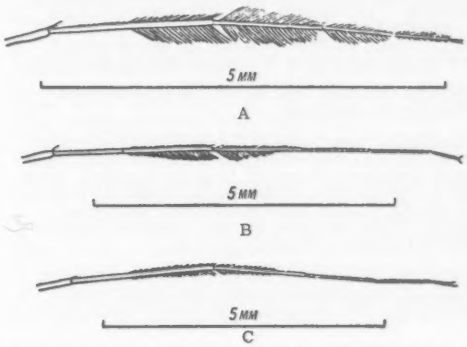

Fig. 6. - Fore tarsus of male: A - Endochironomus albipennis Mg.; B - E. tendens F.; C - E. impar Walk.

Taxonomic comments. The descriptions of the imago given by Edwards (1929) and in Coe's identification key (1950) would identify our species as Endochironomus albipennis Mg. However, these descriptions and key are so compiled that the distinction between the males of this species and of E. tendens F. is very unclear. Edwards used the following features, in addition to variable color characters to identify these two species:

E. albipennis: hairy covering of tarsus uniform in length; slight milky tinge to wings.

E. tendens: weak hairy covering on tarsus; wings grayish, without milky tinge.

Apart from color characters, Coe (1950) only employed the distinction in the hairy covering of the tarsus: according to Goetghebuer (1937) coloration is the only distinction between E. albipennis and E. tendens males and he greatly restricts the color ranges for E. albipennis: E. albipennis – thorax green with brown or blackish-brown longitudinal stripes; E. tendens – thorax light green with reddish mesonotal stripes. Goetghebuer's description of E. albipennis is very brief. No difference between the tarsal covering of E. albipennis and E. tendens males is mentioned. There is therefore a danger of confusing lightly colored specimens of E. albipennis males with E. tendens males. Goetghebuer did not describe the E. albipennis female.

My description does not contradict the original description or those of Edwards, Goetghebuer and Coe. It should be noted, however, that I failed to observe the brown stripe

on the abdominal tergites in fresh specimens of the male mentioned in Coe's key. I found that this stripe sometimes appears in dry specimens and is due to the dried contents of the abdomen. My descriptions are considerably expanded; particular attention is paid to the characters by which the males of this species can be distinguished from E. tendens males. It is difficult to distinguish between the males of these species. It was clearly this that prompted Brundin (1949) to say: "I think it highly doubtful that albipennis is different from tendens". In fact these two species can be well distinguished through the females, and from the early stages of metamorphosis; and are only similar in the male. A key for identification of the adults of these two species is given at the end of this paper.

Edwards (1929) and Goetghebuer (1937) treat E. miki Kieff. as a synonym of E. albipennis. According to Lenz (1921) this species belongs to the "nymphoides" group, and this is not contradicted by our data on the metamorphosis of E. albipennis. I shall retain this synonym for E. albipennis, but shall follow Edwards in placing a question mark in front of it.

It would appear from references in the literature that E. meinerti Kieff., which is one of the species that Goetghebuer (1937) thought to be insufficiently known, is close to E. albipennis. The original description of the male of this species does not clash with my description of E. albipennis. According to Lenz (1921) the larvae and pupae belong to the "nymphoides" group. I have not, however, included the species among the synonyms as I have not had the opportunity of studying the type specimen.

The eggs, 1st-4th larval instars and pupa are here described for the first time.

Distribution. Now reported for the first time for the USSR. Specimens in the collections of the Zoological Institute (USSR Academy of Sciences) from the Yaroslavl, Krasnovodsk (Karabogaz straits) and Semipalatinsk (Irtysh River) regions and the Khakass autonomous region (Minusinsk). Scandinavia, United Kingdom, Holland, Belgium, Western and Eastern Germany, Austria.

In the Uchinsk reservoir the larvae live in refuges on the surface of macrophytes and other submerged objects along the shore. The species has two generations a year.

ENDOCHIRONOMUS TENDENS F., 1794

Fabricius, 1794, Ent. Syst., IV:243, 47.

Syn. trichopus Walk.; alismatis Kieff. sparganiicola Kieff.

Egg mass (Fig. 1, 2). Structure typical of the genus. Color of eggs Ochraceous yellow. (B: d2; R: XV 15' b).

1st larval instar (Fig. 2). Body colorless, yellowish by the end of the stage. Very similar in structure and dize to the 1st larval instar of E. albipennis, but the stripes extending from the bases of the 1st and 2nd lateral teeth of the submentum (C_2) are shorter and more steeply curved to the sides of the submentum. They form a dark band, the width of which is approximately half the length of the superjacent teeth. The width of the band increases by approximately one and a half times toward the sides of the submentum. The length of the median tooth is approximately twice the distance between the level of its base and the posterior margin of the band below it.

2nd larval instar (Similar in structure to 4th larval instar). Body length up to 3 mm. Color pale yellowish rose. Length and width of head average 190 μ. Antennal index 0.70 (0.67-0.78), length of scape 28 (27-30) μ, bristle terminating at the level of the 5th segment. Anterior margin of base of maxillae only slightly irregular (Fig. 7, A). Paralabial plate index 3.30 (3.00-3.40).

3rd larval instar. Similar in structure to the 4th larval instar. Body length up to 6 mm. Color orange. Length of head 380 μ on average, width 315 μ. Antennal index 0.89 (0.81-1.00), length of scape 54 (49-57) μ, bristle terminating between distal third of 4th and proximal half of 5th segment. Anterior margin of base of maxillae carries several teeth along the medial margin (Fig. 7 B). Paralabial plate index 5.09 (4.61-5.55).

4th larval instar. (Fig. 3, A_2, C_2 - F_2). Body length up to 13 mm, color of mature larva miniaceous (B: p 7-p6; R:II 7, Grenadine Red). Head capsule yellow, transparent; contents of head stain it the same color as the body. Average length of head 726 μ, width 589 μ. Antennal index 1.31 (1.22-1.41), length of scape 114 (106-122) μ, bristle terminating at the level of the 4th segment (C_2). Epipharyngeal comb (D_2) consisting of three groups of teeth. Outer teeth of mandibles (E_2) black, 5th proximal tooth false. Anterior margin of base of maxillae entirely covered by large rounded teeth (F_2). Median tooth of submentum (F_2) simple, its base considerably distal to the bases of the lateral teeth; 1st lateral tooth same height as median tooth; 2nd shorter than 3rd and approximately equal to it in height; 5th considerably smaller than 6 th and approximately equal to it in height; 7th small and situated considerably below the 6th. Paralabial plate index 5.09 (4.61-5.55).

Pupa. (Fig. 4, C_2). Length 8-9 mm. Exuviae dirty yellow (B: b 5-k 5; R:XXX 19" i). Shagreening on 2nd-7th tergites consisting of dirty yellow spinules of various size: the largest and darkest in 2-3 rows along the anterior margin of the 2nd-6th tergites; the medium size spinules concentrated along the posterior margins of these tergites; and the small spinules covering the central area of the 2nd - 6th tergites, forming a shagreened band along the anterior margin of the 7th tergite. No spines apparent in the intersegmental folds. Shagreening of very fine solitary spinules, with two or more in a row, on the anterior sector of the 8th tergite, the tergite of the anal fine, and the 6th-8th sternites. Shagreening similar solitary spinules on the 2nd sternite. No shagreening on remaining

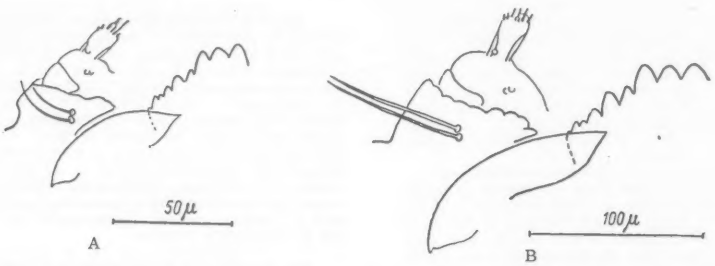

Fig. 7. - Maxillae of Endochironomus tendens F. larvae. A - 2nd instar; B - 3rd instar.

sternites. 2-4 long marginal bristles on 7th-8th segments; remaining marginal bristles short and fine. Teeth of anal-lateral combs of 8th segment (C_2) yellowish brown (B: d 2 + d 7; R:XV 13' i). The sloping arc of the comb not reaching the lateral margin of the segment; 6-9 teeth in each comb; 3rd-5th of approximately the same size, and larger than the others. The area embraced by the arc has in addition, 1-3 subsidiary denticles. The outer margin of the anal fine is covered with bristles of two kinds: the proximal 3/5 of the margin of each lobe is covered by long transparent bristles, none of which is as long as the fine; the anal 2/5 of the margin has short, consolidated dark bristles; at the apical angles of the fine blades, these bristles form a whorl. The lobes of the sexual appendages are the same as in E. albipennis.

Imago (Fig. 5, A_2-D2). ♂. Basic body color yellowish green (color chart reference on page 910). Funiculus and mouth parts brown to blackish brown. Scapes, mesonotal bands, postnotum and mesosternum reddish yellow, without brown pigmentation. Color of scutellum varies between basic color and yellow, and of episternum between yellow and reddish yellow. Legs pale green or pale yellow; ultimate, or ultimate and penultimate, tarsal segments brown. Scales on distal end of fore tibia (B_2) terminate in a strictly apical spur. Combs of distal end of middle and hind tibia (C_2 and D_2) similar to those of E. albipennis. Fore tibia and basal part of 1st segment of fore tarsus with very short appressed hairs; towards the distal end of the first segment of fore tarsus there is a gradual and slight increase in the length of the hairs leading to the formation of a short fringe; the length of the hairs gradually decreases toward the distal end of the tarsus, and the fringe disappears by the middle of the 2nd segment. The maximum length of the fringe on the 1st segment of the tarsus is considerably less than the length of the hairy covering on the fore and hind tibiae (Fig. 6, B). L. R. - 1.30 (1.17-1.45); Mt. S. R. - 4.32 (4.00-4.75). Wings transparent, colorless; length 4.25 (3.50-4.75) mm, width 1.02 (0.85-1.15) mm. Abdomen yellowish green. Hypopygium (A_2) yellow, extremely similar to that of E. albipennis except that the bristles cover slightly less of the aedeagus; the bristle-free proximal sector is approximately the same length as the covered distal sector or even slightly longer. Body length 6.17 (5.50-7.25) mm.

♀. Head, thorax and abdomen reddish brown (B: c'1; R: XV 9' i). The lighter antennae and legs have the same tinge. Fore legs uniformly covered by short appressed hairs, no fringes. L. R. - 1.23 (1.16-1.34); Mt. S. R. - 4.27 (4.00-4.84). Wings transparent, with a reddish-brown tinge: length 4.97 (4.50-5.75) mm, width 1.23 (1.00-1.37) mm. Length of body 5.00 (4.25-5.50) mm.

Taxonomic comments. The imago of this species is identified from Edwards' descriptions (1929) and from Coe's key (1950) as Endochironomus tendens F. Edwards' description does not contradict the original description. The species was briefly described by Fabricius (1794) from a female with a rust colored body (corpus ferrugineo). Edwards gave a brief description of a green male of this species, and a somewhat more detailed description of the female (he stated that the green color was absent from the body of the female). My description of the male and female does not clash with Edwards' description, but is considerably expanded. Particular attention has been paid to the characters that distinguish this species from E. albipennis Mg.

The only synonym that Edwards gives of E. tendens is E. trichopus Walk. The metamorphosis of E. trichopus is unknown. I follow Edwards in retaining this name as a synonym of E. tendens.

In Coe's key it is stated that there may be a brown medial stripe on the abdomen of the male E. tendens, but I only noticed it in dry specimens.

My description does not clash with the brief description given by Shilova (1952) of E. tendens from the basin of the Amur River.

By Goetghebuer's key for identification (1937) the males of this species should be identified as E. tendens F., but his description of the imago of E. tendens differs from mine. According to Goetghebuer's description, there is no difference in the hairy covering of the fore tarsus between E. tendens and E. albipennis; this clashes with the descriptions given by Edwards and with my descriptions of these two species. It also appears from Goetghebuer's descriptions (1928, 1937) and from his key (1928) that the female does not differ in coloration from the male; i. e. that the basic color is green. This clashes with my description.

Nevertheless, it is difficult to suppose that Goetghebuer was describing as E. tendens a species that differs from E. tendens as understood by Edwards. None of the 10 Endochironomus species indicated by Goeghebuer for the Palaerctic region is closer to E. tendens as understood by Edwards than E. tendens (F.) Goet., 1937. Since the species E. tendens is widely distributed in Europe, one can scarcely assume that it is absent from Goetghebuer's monograph and that he was describing another species under the name tendens.

Some of the characters of E. tendens (F.) Goet., 1937 (green female, fringe on fore tarsus of male) make it similar to E. albipennis Mg. as understood by Edwards. Nevertheless one cannot assume that E. tendens (F.) Goet., 1937 is identical to E. albipennis Mg. as understood by Edwards. Goetghebuer (1912, 1928) has described the metamorphosis of E. tendens. In his descriptions, the larvae and pupae of this species belong to the "signaticornis" group; while, according to my data, the larvae and pupae of E. albipennis belong to the "nymphoides" group. E. miki, which Edwards gives as a synonym of E. albipennis, also belongs to the "nymphoides" group (Lenz, 1921).

These facts and the synonymy of Goetghebuer indicate that E. tendens (F.) Goet., 1937, is a collective species, in the description of which the characters of two species — E. tendens F. and E. albipennis Mg. — have been confused. There is some reason for such a confusion, since it is difficult to distinguish between the males of these two species, and the female of E. albipennis is more similar in coloration and in the hairy covering of the fore tarsus to males of E. tendens than to males of its own species.

In addition to E. tricopus, Goetghebuer also gives 9 of Kieffer's species as synonyms of E. tendens. Four of them (E. nymphoides Kieff., E. xantholabis Kieff., E. nymphella Kieff. and E. calolabis Kieff.) belong (Lenz, 1921) to the "nymphoides" group, and cannot, therefore, be synonyms for E. tendens. This is also indicated by information on the biology of these species; their larvae live in the open; whereas the larvae of E. tendens, according to Goetghebuer (1928) and to my observation, are miners. According to Lenz, E. alismatis Kieff. and E. sparganicola Kieff. belong to the "signaticornis" group; I shall retain these species as synonyms of E. tendens. It is interesting to note that, according to Thienemann (1954), the larvae of these "species" are miners. E. danicus Kieff and E. bryozoarum Kieff. are questioned by Goetghebuer as synonyms of E. tendens. Both these species were described from the female. According to Goetghebuer (1928) the female of E. bryozoarum has 6-segmented antennae. I therefore assume that this species can be included as one of the synonyms of E. tendens. Thienemann (1954) classifies E. danicus as a synonym of E. tendens Thienemann, 1954 (nec. F.) on the basis of larvae; i. e., he ascribes it to the "nymphoides" group in our sense. I am therefore unable to retain this species as a synonym of E. tendens. According to Thienemann the larvae of E. danicus live in the open.

Two of the species classified by Goetghebuer (1937) as insufficiently known show similarity to E. tendens in my sense, (E. longiclava Kieff. and E. signaticornis Kieff.) It would appear from the descriptions of the imago, the structure of the larvae and pupae (Gripekoven, 1914) and the mode of life (Thienemann, 1954) that these species are close to E. tendens in my sense. Since I have not had the opportunity of studying the type specimens, I have decided against including them among the synonyms solely from references in the literature.

In Thienemann's opinion it "is hardly possible to say accurately what was meant by the original tendens

Fabricius" (p. 98), and he therefore treats as synonyms of E. tendens all of Kieffer's species belonging to the "nymphoides" group, in addition to the species albipennis Mg. and tricopus Walk. E. tendens Thienemann, 1954, is not E. tendens in my sense.

The eggs of E. tendens have been briefly described by Munsterhjelm, (1920). My descriptions of the 1st, 2nd and 3rd larval instars are the first. The 4th larval instar has been described by Goetghebuer (1912). Goetghebuer only records 13 teeth on the larval submentum, since he does not take into consideration the small 7th teeth. My description is considerably expanded. The pupa has been described by Goetghebuer (1912) and Shilova (1952). My description of the pupa is much more detailed, but does not clash with those first descriptions. It is stated in Shilova's description that there are no spinules of the 6th and 7th tergites; this does not accord with my description of the pupa.

Distribution. USSR: the collections of the Zoological Institute (USSR Academy of Sciences) contain specimens from the Leningrad and Pskov regions and the Krasnodar subdistrict (Goryachiy Klyuch). Scandinavia, United Kingdom, West and East Germany, Belgium.

In the Uchinsk reservoir the larvae bore into dead portions of various macrophyllous plants and the green parts of macrophyllous plants with soft succulent tissues (but reed and arrowhead). There are two generations a year in the reservoir.

ENDOCHIRONOMUS IMPAR WALK, 1856

Walker, 1856, Ins. Brit. III:174, 97.

Syn. involitans Walk.

Egg mass (Fig. 1, 3-4). Structure typical of the genus. Color of eggs brown (B: k 7; R:III 13 m).

1st larval instar (Fig. 2, C_3-D_3). Body length up to 1.5 mm, color becoming whitish rose towards the close of the stage. Similar in structure and size to the 1st larval instar of E. albipennis; but the stripes running back from the bases of the submental teeth (C_3) are considerably longer, and the dark band that they form is much wider. Beneath the 1st and 2nd lateral teeth, the width of this band is twice their length. The band is as wide in the middle of the submentum as at the sides. The ratio of the length of the median tooth to the distance between the level of its base and the posterior margin of the band is 3:4.

2nd larval instar. Similar in structure to 4th larval instar. Body length up to 3 mm, color rose. Average of length of head 128 μ, width 190 μ. Antennal index 0.69 (0.67-0.78), length of scape 28 (27-30) μ, bristle terminating between the distal third of the 4th and the proximal fifth of the 5th segment. Paralabial plate index 2.74 (2.60-2.80).

3rd larval instar. Similar in structure to 4th larval instar. Body length up to 7 mm, coloration slightly lighter in adult larva. Average length of head 408 μ, width 332 μ. Antennal index 0.96 (0.94-1.00), length of scape 62 (57 - 65) μ, bristle terminating at the level of the 5th segment. Paralabial plate index averages 3.75.

4th larval instar (Fig. 3, C_3-F_3). Body length up to 12 mm; body color of adult larva carmine (B: p 7' m 5; R: I, 3, Scarlet-Red), with a delicate blackish-green marbled pattern on the thoracic segments. Head capsule light brown, transparant; the contents of the head give it a reddish color. Average length of head 735 μ, width 570 μ. Antennal index 1.22 (1.11-1.33), length of scape 109 (103-114) μ, bristle terminating between distal third of 4th and proximal fifth of 5th segment (C_3). Epipharyngeal comb (E_3) consisting of three groups of teeth. All external teeth of mandibles (E_3) black, 5th proximal tooth somewhat removed from the base. Anterior margin of base of maxilla only slightly irregular (F_3). Two teeth in middle of submentum (F_3), their bases being greatly distal to the bases of the lateral teeth. 1st lateral teeth clearly larger and higher than the median teeth, 2nd much smaller and lower than the adjacent teeth, 5th approximately equal in size and height to the 6th, 7th small and placed low.

Pupa (Fig. 4, A_3-C_3). Length 8-10 mm. Exuviae transparent, colorless, brown in places (B: o 7; R:XIV 9' m). Shagreening of brown spinules on 2nd - 6th abdominal tergites. Spinules of varying size; the largest and darkest spines form 2-3 tight rows along the anterior margin of the 2nd-5th tergites; on the 6th tergite, this anterior band consists of 4-5 looser rows of somewhat smaller spinules; in the middle of the 2nd-6th tergites, smaller brownish spinules, increasing in size posteriorly on the 2nd tergite and decreasing on the 3rd-6th tergites. Circular areas free from shagreening are clearly visible owing to the dark color of the denticles and the colorless exuviae (A_3). There are several rows of medium sized yellowish-brown, apically antrorse, spinules in the intersegmental folds between the 3rd and 4th and 4th and 5th tergites (see A_3). Shagreening of very fine spinules arranged in rows of 2 to 8 on the 7th-8th tergites and on the 1st-3rd and 5th -8th sternites (B_3), the spinules being longer and in longer rows toward the end of the body. Only the proximal parts of the 7th and 8th tergites are shagreened; there are 2 median spots of shagreening on the 1st sternite; the 2nd sternite is uniformly shagreened, the 3rd laterally and the 5th to 8th anteriorly. The 4th sternite is not shagreened but carries "false legs" at the posterior angles (small protruberances covered with long pointed light spinules). Long marginal bristles on 5th-8th segments: 3, 3, 4, 4. Teeth of anallateral combs (C_3) of 8th segment brown. Comb curves steeply forward and extends slightly along the lateral margin of the segment; 4 - 8 teeth in the arc, 1 or 2 of which are much larger than the others. Only long transparent bristles with darkened bases along the outer margin of the anal fine (C_3). Longest bristle approximately twice as long as the fine. Whorls of bristles absent from the anal angles of the fine blades. Lobes of the male sexual appendages normally twisted inwards like the finger of a glove, when straightened they protrude far beyond the fine; the female lobes reach the posterior margin of the fine.

Imago (Fig. 5, A_3-D_3) ♂. Head, palpi and pronotum blackish brown. Mesonotum, mesosternum and postnotum black and shining with a very light silvery sheen. Color intensity on the legs varies. In deeply colored specimens, the fore femur is yellow , and the distal end of the femur, the tibia and the tarsus of the fore leg are dark brown; the middle and hind legs are yellowish brown, the femora being slightly lighter, and the distal ends of the femora, the distal and proximal ends of the tibiae and the apical tarsal segments somewhat darker. In lightly colored specimens, all the legs are yellowish and only areas near the joints of the femora and tibiae, and the distal ends of the tibiae and the tarsal segments, are somewhat darker. No spur on the scale on the distal end of the fore tibia (B_3), which is apically rounded. The fused combs on the middle tibia have one spur (C_3); the dividing line between the combs on the hind tibia cannot be seen, and the outer spur is either smaller than the inner spur or absent (D_3). Fore legs covered with short appressed hairs, the length of which increases slightly toward the distal end of the 1st segment of the fore tarsus, and decreases again toward the middle of the 2nd tarsal segment (Fig. 6, C) L. R. — 1.20 (1.15 — 1.27). Wings transparent, with a brownish tinge, length 4.43 (4.00-4.75) mm, width 0.96 (0.85-1.00) mm. Halteres have a transparent blade and a brown stem. Scutellum and abdomen brownish (B: ~ d 7; R:XVI 17 ' m); yellow longitudinal spots near the anal-lateral angles of the abdominal tergites; in lightly colored specimens, the color of each tergite lightens to yellow toward the posterior margin. Hypopygium (A_3) brownish, similar to that of E. albipennis, except that all the bristles are thicker and longer. Body length 6.85 (6.50-7.25) mm.

♀ Antennae yellow or brownish. Thorax, legs and wings same color as in males. Abdomen dark brown. Fore legs uniformly covered by very fine appressed hairs. L. R. 1.20 (1.17-1.27). Length of wings 4.69 (4.25-5.50) mm, width 1.12 (1.00-1.25) mm. Body length 4.68 (4.25-5.75) mm.

Taxonomic remarks. Walker (1856) described a male and female of different genera (Edwards, 1929) under the name E. impar Walk. According to Edwards (1929) the male belongs to the genus Prodiamesa and the female to Endochironomus. When describing a male identical to the female described by Walker, Edwards (1929) retained the name impar for the species.

Our specimens of the imago differ from those described by Edwards, Goetghebuer (1937), Coe (1950) and Shilova (1952), in that there is a much greater range of color variation. This makes them nearer to the E. dispar described by the same authors. On the other hand, the extremely short hairy covering of the fore tarsus makes it impossible to identify our specimens as E. dispar Mg. My identification has been confirmed by my colleague Dr. Freeman of the British Museum, who compared my specimens with those in the museum. There is no fundamental difference between a specimen of E. impar from the United Kingdom that he was kind enough to send (collected by Edwards and identified by Freeman) and my specimens.

Edwards (1929) and Goetghebuer (1937) give E. involitans Walk. as a synonym of E. impar. I follow them in including this name among the synonyms of E. impar.

My description of the development of the species is the first.

Distribution. USSR (Amur basin, Bolon' district). The collections of the Zoological Institute (USSR Academy of Sciences) include specimens from the Leningrad region. Scandinavia, United Kingdom, Holland.

In the Uchinsk reservoir the larvae bore into the dead parts of macrophytic plants and are also found among plant residues on the bed. The species has two generations a year in the reservoir.

KEY FOR IDENTIFICATION OF IMAGO OF ENDOCHIRONOMUS ALBIPENNIS Mg. AND E. TENDENS F.

Males

1 (2). Scapes, mesonotal bands, mesosternum and postnotum reddish yellow (B: zh 2; R; XV 15 ', Ochraceous-Orange) to dark brown (B: o 7; R: XXVIII and 7" m). Distal 3rd (or 1/2) of 1st segment of fore tarsus and 2nd tarsal segment with a fringe of hairs (Fig. 6, A). Length of fringe approximately equal to the hairy covering on the middle tibia. A sharp transition between the very short covering of the proximal part of 1st segment of fore tarsus and fringe of distal part. Spur on scale of fore tibia not strictly apical but slightly to the side (Fig. 5, B_1). L. R. - 1.14 (1.03-1.20); Mt. S. R. — 3.29 (2.91-3.87)..... albipennis Mg.

2 (1). Spaces, mesonotal bands, mesosternum and postnotum reddish yellow (color scale above), never with brown pigmentation. Length of hairs on 1st segment of fore tarsus increases gradually and slightly towards its distal end and decreases gradually toward the middle of the 2nd tarsal segment (Fig. 6, B). Maximum length of fringe somewhat less than length of hairy covering on middle tibia. Spur on scler of fore tibia apical (Fig. 5, B_2). L. R. — 1.30 (1.17-1.45); Mt. S. R. —4.32 (4.00-4.75)..... ..... tendens F.

Females

1 (2). Thorax and abdomen yellowish green (B: e 7 - i 2; R: XVII 24' Apple Green). Mesonotal bands, mesosternum and postnotum greenish yellow to reddish-yellow, very occasionally light brown. Wings colorless. Legs without hair fringes. L. R. - 1.08 (1.02-1.18); Mt. S. R. -3.12 (2.95-3.35)..... ..... albipennis Mg.

2 (1). Thorax and abdomen reddish brown (B: vi; R: XIV 9' i), the antennae, legs and wings of the same shade. Legs without hair fringes. L. R. - 1.23 (1.16-1.34); Mt. S. R. - 4.27 (4.00-4.84)..... ..... tendens F.

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ESTONIAN SPECIES OF THE GENUS ATRICHOPOGON KIEFFER (DIPTERA, HELEIDAE), II. DESCRIPTION OF THREE NEW SPECIES AND KEY FOR THE IDENTIFICATION OF ESTONIAN SPECIES OF THE SUBGENUS ATRICHOPOGON S. STR[1]

KH. YA. REMM

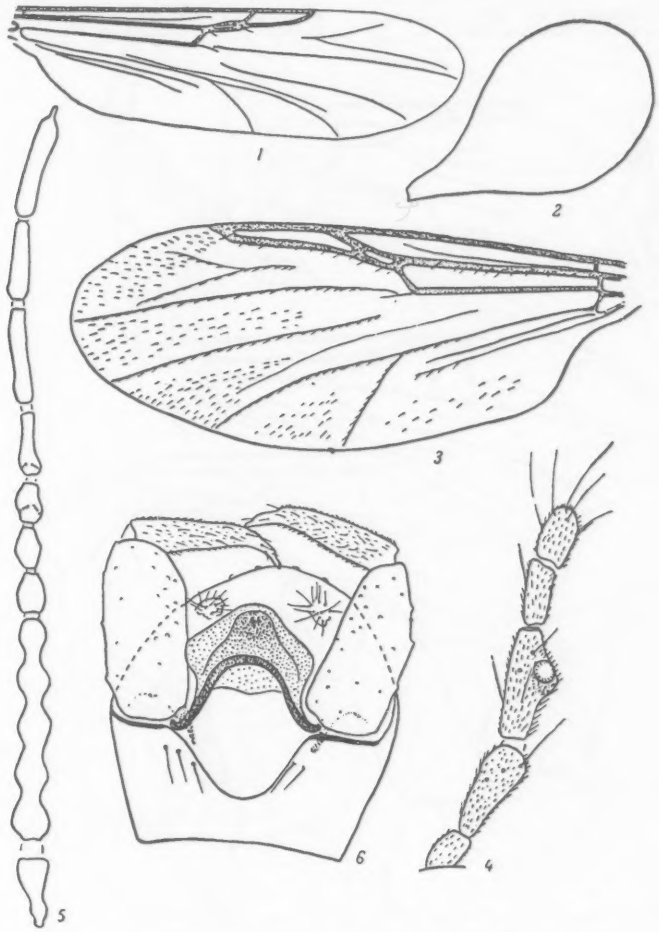
I have discovered 14 species of the subgenus Atrichopogon s. str., in Estonia, 3 of which are described as new species. The Estonian fauna thus contains not less than 18 species of the genus.

Type specimens of the new species are preserved in the collections of the Institute of Zoology (USSR Academy of Sciences) in Leningrad and paratypes in the collections of the Zoological Faculty at the Tartu State University.

[1] The first part of this work (Entom. obozr., 38, 1959) contains descriptions of four species of the subgenus Psilokempia End.

Atrichopogon majusculus, sp. n.

A large thickset species with the eyes covered with short hairs and the wings with macrotrichia, similar to A. rostratus Winn.



Figs. 1-6.- Atrichopogon majusculus, sp.n.: 1 - wing of male; 2 - spermatheca; 3 - wing of female; 4 - female palp; 5 - male antennae; 6 - hypopygium.

Female: Body length 2-2.5 mm, wing length 1.8-2.1 mm.

Head blackish brown with yellow hairs. Eyes normally entirely covered with hair. Proboscis as long as, or slightly shorter than, the height of the head. Clypeus convex, dark brown, sometimes with a reddish tinge. Palpi (Fig. 4) dark brown; distal half of segment III noticeably thickened, with a large sensory pit; segments II-V relatively long – 7.5: 8.6:4.5:4.2. Antennae (Fig. 21) blackish brown; segments IV-X practically spherical, segments XI-XV cylindrical. Relative lengths of apical six segments 4:10:10:11:11:13. Antennal index 1.6-1.85.

Thorax blackish brown, slightly lustrous; scutum with a delicate yellowish sheen and sparse light and dark hairs. Scutellum blackish brown or dark brown with four black bristles. Legs entirely yellowish brown. Comb of eight long bristles on hind tibia. Claws bearing small denticles on the inner face. Wings (Fig. 3) with a profusion of macrotrichia on the apical 2/5 and along the posterior margin. In the 1st medial cell the macrotrichia extending noticeably farther toward the base of the wing than in the adjacent cells. Second radial cell approximately 2-3.5 times as long as the 1st. Halteres brownish; apical head dirty yellow.

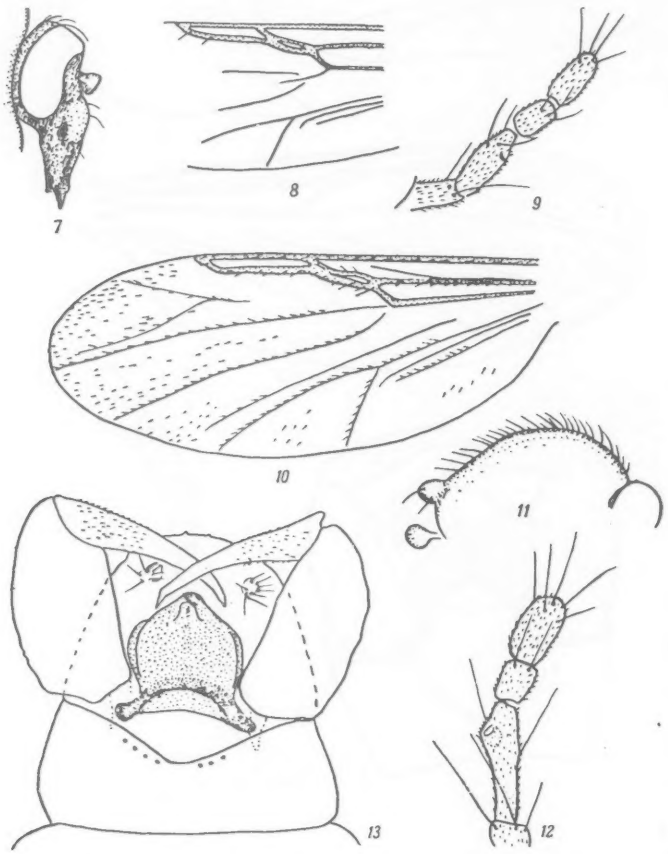
Abdomen dark brown or blackish brown, mat, with short hairs with a yellow luster. Cerci yellowish. Single pear-shaped spermatheca (Fig. 2) with a fairly long neck. Size approximately 16 x 6.8 mm/100.

Male similar to female. Body length 2.5 mm, wing length 2-2.1 mm.

Proboscis short, approximately 3/5 the height of the head. Antennal tuft dark brown with yellow luster, extending to last segment. Rosette of hairs practically encircling segments IV-XII. Segments IV-XI elongate (Fig. 5), IV-VIII fused. Relative lengths of apical six segments 5:5:9:13:11:14. Antennal index. 1.1. Apical claws deeply cleft. Wings (Fig. 1) normally without macrotrichia in cells. Second radial cell approximately 2-2.5 times as long as the 1st.

Hypopygium (Fig. 6). A deep triangular notch with 1-3 lateral bristles on 9th sternite. 9th tergite failing to reach the apex of the gonocoxites or projecting slightly beyond them. Gonosternum typical of the fuscus group.

Holotype (♀): shore of Lake Ermistu, Pärnu district, 21 June 1953. Remaining material from Estonia (paratypes): Vyandra district, Viluvere, 24 July 1954, 6 ♀♀; Likhula district, Kyaomardi Bay, 24 June 1953, 2 ♀♀; Pylva district, Lake Aru, 31 July 1953, 1 ♂, 1 ♀; Pyltsama district; Lake Parika, 18 June 1953, 4 ♀♀; Pärnu district, lake



Figs. 7-13.- Atrichopogon hirtidorsum, sp.n.: 7 - head of female in profile; 8 - part of wing of male; 9 - palp; 10 - wing; 11 - female scutum; 12 - male palp; 13 - hypopygium.

Lavassaare, 20 June 1953, 1 ♂, 7 ♀♀; Lake Ermietu, 21 June 1953, 9 ♂♂, 31 ♀♀; Lake Tykhela, 23 June 1953, 1 ♀; Rapla district, Lake Loosalu, 29 June 1953, 1 ♀; Lake Yarlepa, 30 June 1953, 1 ♀; Tapa district, Tamsalu, 12 June 1953, 1 ♀; Tartu district, Vorbuse, 30 June 1954, 1 ♀; Lake Leegu, 28 July 1953, 1 ♀, 3 ♀♀; Khaapsalu district, Lake Khindaste, 9 July 1953, 1 ♀; Lake Tyanav''yarv, 9 July 1953, 1 ♀.

Similar to A. seminitidus Goetghebuer, although in A. seminitidus segments III-X of the female antennae are transverse and the antennal index is 2.

Atrichopogon hirtidorsum, sp. n.

Similar in appearance to A. fossicola Kieff., but somewhat smaller and scutum more hairy.

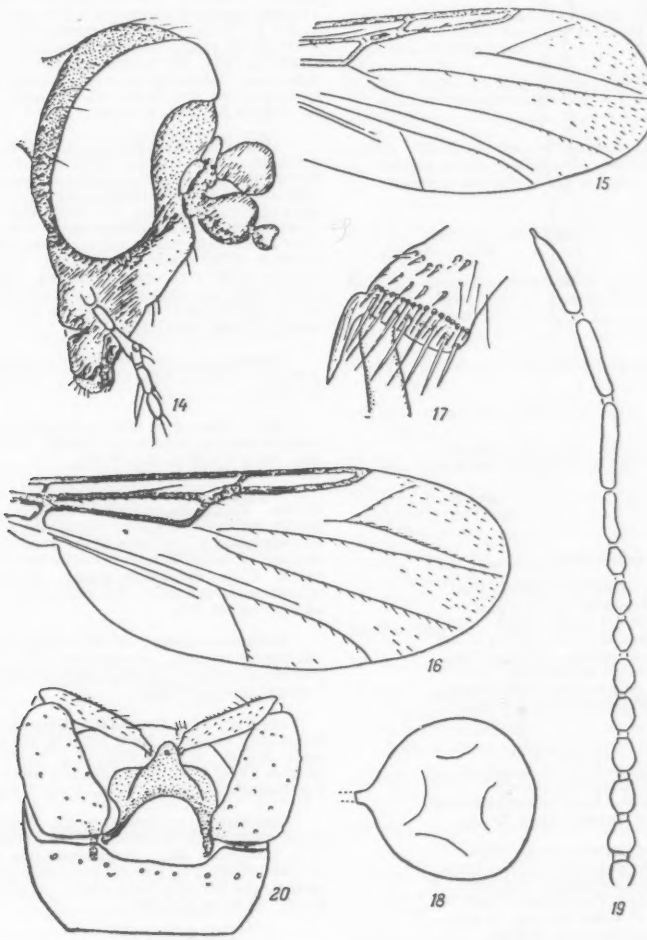
Female: Body length 1.2-1.9 mm, wing length 1.3-1.65 mm

Head (Fig. 7) blackish brown; eyes bare or partly covered with hair. Proboscis dark brown, 2/3-3/4 the height of the head. Mandibles with approximately 10 denticles. Clypeus slightly rounded. Palpi (Fig. 9) brown; relative length to apical 4 segments 5:7:3:4.5. Antennae (Fig. 22) dark brown, basal segments of flagellum slightly transverse VIII-IX almost spherical, X a little longer than its own width. Relative length of apical six segments 3:7:7:7:7:10.

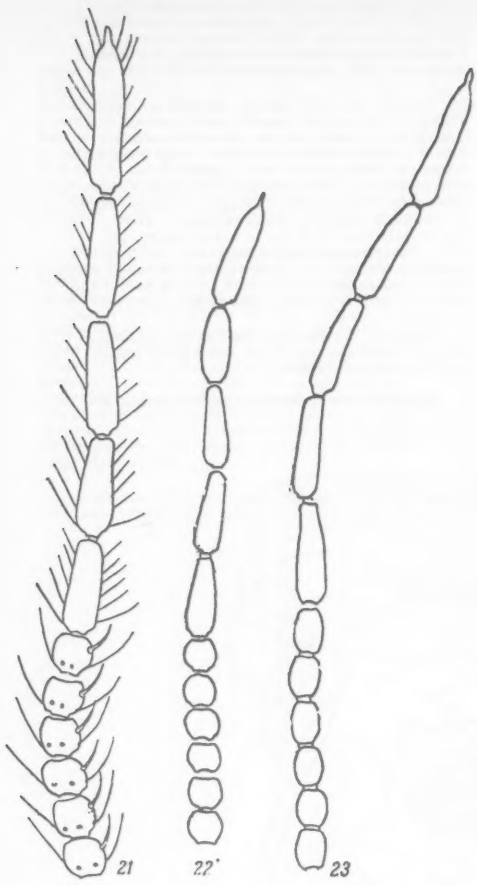
Scutum blackish brown, slightly iridescent with a grayish-brown luster and relatively long (Fig. 11) dark hairs. Scutellum often lighter, brown, with 4 bristles. Legs yellowish brown or brown, tarsi often lighter; hind tibia with comb of 8 long bristles; claws on inner face with a tooth near apex. Wings (Fig. 10) slightly smoky, veins brownish. They are usually macrotrichia in all the marginal cells from the apex to the anal cell, but they are usually isolated (1-6) in the cubital and anal cells. Second radial cell 3-3.5 times as long as the 1st. Halteres usually brown, apex of head lighter.

Abdomen brown with short grayish hairs. One spermatheca, pyriform, neckless, length approximately 0.14 mm.

Male similar to female. Body length 1.45-



Figs. 14-20. - Atrichopogon longicalcar, sp.n.: 14 - head of female in profile; 15 and 16 - wings of female; 17 - apex of hind tibia of female; 18 - spermatheca; 19 - male antennae; 20 - hypopygium.



Figs. 21-23.- Female antennae: 21 - Atrichopogon majusculus, sp.n.; 22 - A. hirtidorsum, sp.n.; 23 - A. longicalcar, sp.n.

1.5 mm. Wing length 1.2-1.5 mm.

Antennae brown, segments IV-X fused. Relative length of apical six segments 3.5:4:6.3:11:10:11. Well developed tufts of hairs with a yellow luster extending almost to the apices of the antennae. Claws divided at apices. Wings (Fig. 8) without macrotrichia on the membrane. Isolated macrotrichia (1-4) only on the radial veins. Second radial cell approximately twice the length of the 1st.

Hypopygium (Fig. 13). Groove on IX sternite shallow, obtuse angled, 6-10 marginal bristles. Upper half of gonostyle slender, slightly curved and hairless. Body of gonosternum almost equal in length to its width. Legs short.

Holotype (♀): shore of Lake Loosalu, Rapla district, 22 June 1953. Remaining material from Estonia (paratypes): Vyandra district, Viluvere, 24 and 29 July 1955, 1 ♂, 3 ♀♀; Keyla district, Lake Englema, 8 July 1953; 1 ♂; Lake Klooga, 10 July 1953, 18 ♂♂, 11 ♀♀; Likhula district, Pukhtu, 25 June 1953, 1 ♂, 1 ♀; Pärnu district, Lake Ermistu, 21 June 1953, 3 ♀♀; Rapla district, Lake Loosalu, 28 and 29 June 1953, 13 ♂♂, 16 ♀♀; Lake Yarlepa, 30 June and 10 July 1953, 2 ♂♂, 3 ♀♀; Tartu district, Lake Lezgu, 28 July, 1953, 1 ♀; Luun'ya, 24 June 1954, 2 ♂♂; Vorbuse, 30 June 1954, 1 ♀; Tyrva district, Pikasilla, 9 July 1954, 1 ♂, 1 ♀; Tyrva, 9 July 1954, 1 ♀; Elva district, Rannaküla, 15 June 1954, 1 ♂; 7 and 8 July 1954, 1 ♂, 8 ♀♀.

The species is clearly distinguishable from closely related species of the fuscus group by the long hairs of the scutum, which are 0.05-0.07 mm long as against a normal length of 0.02-0.04 mm for the other species of the genus investigated (except A. lucorum Mg.). The structure of the hypopygium is also distinctive.

This is a typical summer species, which is most plentiful in late June and early July.

Atrichopogon longicalcar, sp. n.

A short, black species; legs yellow, halteres white, flagellar segments elongated.

Female: Body length 1.4-1.7 mm, wing length 1.4 mm.

Head blackish brown. Eyes hairless or covered with hair. Proboscis short and thick, approximately as long as half the height of the head (Fig. 14). Clypeus slightly rounded. Labrum hairless apically. Palpi short; relative length of segments approximately 3:3.6:5.8:3.6:3.8. Basal 2/3 of segment III slightly thickened; sensory pit practically in the middle of the segment. Antennae (Fig. 23) brown; segments III and IV almost spherical, following segments elongated, X 1-1/2 times as long as its own width, XI approximately 2-1/2 times as long as X. Antennal index 1.6-1.8.

Thorax blackish brown, scutum black, shining, with delecate grayish-brown luster and sparse black hairs. Scutellum with 4 black bristles. Legs yellowish, claws with a tooth situated subapically on inner face. Comb at apex of hind tibia (Fig. 17) consisting of 7-8 bristles, the outer of which is somewhat shorter than the others. Spur abnormally large and considerably longer than the bristles of the comb. Wings (Fig. 15, 16) bearing macrotrichia in the apical quarter. A few macrotrichia are sometimes also found in the cubital cell. 2nd radical cell 2-1/2-3 times as long as the 1st. Costal veins brownish. Halteres pure white.

Abdomen blackish brown, cerci yellowish. One spermatheca, almost spherical (Fig. 18) with a very short neck.

Male (described from materials from the Transcarpathian region) similar to female. Body length 1.3-1.6 mm, wing length 1.5-1.6 mm.

Head and thorax black; proboscis and palpi yellowish brown. Flagellum and tuft of antennal bristles yellow, partly darkened, flagellar segments not fused (Fig. 19); tuft extending to the apex of the penultimate segment. Scutum shining, with delicate grayish luster and sparse short hairs. Claws divided at apices. Wings without macrotrichia on membranes; 2nd radial cell approximately twice as long as the 1st.

Abdomen blackish brown; tergite segment IX brown, slightly iridescent. Hypopygium (Fig. 20) small; groove on sternite IX very shallow; sternite IX with a single row of bristles.

Holotype (♀): Rannaküla, Elva district, 8 July 1954. Remaining material from Estonia (paratypes): Keyla district, Klooga, 10 July 1953, 1 ♀; Tartu district, Vorbuse, 30 June 1954, 7 ♀♀; Elva district, Ryngu, 16 June 1954, 1 ♀; Rannaküla, 8 July 1954, 6 ♀♀; 9 August 1954, 3 ♀♀.

Distribution outside Estonia: Transcarpathian region, Komi ASSR. The structure of the antennae is reminescent of A. brunnipes Mg., from which this species can easily be distinguished by color; the scutum is black, the legs are yellow, the halteres pure white. It differs from A. longiserra Kieff. in being smaller.

KEY FOR IDENTIFICATION OF THE SPECIES

1 (2). Thorax yellow, scutum with 3 wide brown longitudinal

Fig. 24. - Head of female Atrichopogon rostratus Winn.

Fig. 25. - Head of female Atrichopogon lucorum Mg.

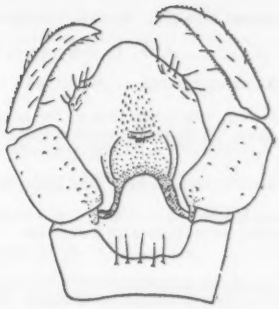


Fig. 26. - Hypopygium of Atrichopogon aethiops Goet.

stripes.....1. A. trifasciatus Kieff.

2 (1). Thorax black or brown; scutum more or less unicolorous.

3 (28). Females.

4 (9). Wings almost entirely covered in macrotrichia, less so beneath the basal cell. Two spermathecae.

5 (6). Antennal segments III-X transverse; proboscis curving noticeably forward (Fig. 25).....
..... 4. A. lucorum Mg.

6 (5). Antennal segments III-X more or less spherical; proboscis almost straight.

7 (8). Body length approximately 1.5 mm. Antennae blackish brown .....
.....5. A. oedemerarum Storà.

8 (7). Body length approximately 2 mm. Second antennal Segment reddish.....
.....6. A. orbicularis Kieff.

9 (4). Fewer macrotrichia on wing.

10 (11). Length of proboscis exceeding height of head; proboscis slender, curving slightly backward apically (Fig. 24). Many macrotrichia in marginal cells from apex of wing to anal cell. Two spermathecae. Length approximately 2-2.5 mm.....
.....7. A. rostratus Winn.

11 (10). Proboscis shorter, not longer than head. One spermatheca.

12 (15). Antennal segments III-X elongate.

13.(14). Body length approximately 2 mm. Legs brownish, halteres yellowish. Macrotrichia on wings present to anal cell.....12. A. brunnipes Mg.

14 (13). Body length approximately 1.5 mm. Legs yellow, halteres white. Macrotrichia normally absent from anal and cubital cells. Spur on hind tibia longer than bristles of comb.....
.....13. A. longicalcar, sp. n.

15 (12). Antennal segments III-X transverse or spherical.

16 (17). A few (7-13) macrotrichia confined to the apex of the wing in the 5th radial cell (very occasionally also isolated macrotrichia in the medial cell). Wing length 1.1-1.35 mm. Scutellum with 2 bristles. Legs yellow.....14. A. minutus Mg.

17 (16). Macrotrichia also present on other cells. Legs darkened.

18 (21). A few macrotrichia confined to the outer margin of the 5th radial and 1st medial cells. Wing length 1.2-1.4 mm. Antennal index 1.2-1.3. Eyes covered with hair.

19 (20). Halteres dirty-white or light brown; antennal segment IX approximately 1.5 times the length of X.....2. A. pavidus Winn.

20 (19). Halteres brown; antennal segment XI approximately twice as long as X; sternite VII with a deep groove on the posterior margin.....
..... 3. A. aethiops Goet.

21 (18). Macrotrichia normally also present on cubital and anal cells.

22 (23). Hairs on scutum long, approximately 0.05-0.07 mm. Eyes bare or almost bare. Wing length approximately 1.5 mm.....
.....11. A. hirtidorsum, sp. n.

23 (22). Hairs on scutum short, approximately 0.02-0.04 mm.

24 (25). Eyes bare or almost bare. Wing length 1.5-1.85 mm.....8. A. fossicola Kieff.

25 (24). Eyes entirely covered by hairs.

26 (27). Body length 2-2.5 mm. Antennal segments IV-X almost spherical.....
.....10. A. majusculus sp.n.

27 (26). Body length approximately 1.5 mm. Antennal segments IV-X transverse.....
.....9. A. infuscus Goet.

28 (3). Males.

29 (38). Apical macrotrichia on wings.

30 (33). Antennal tuft poorly developed, far from reaching the end of the antennae; antennal segment XII with only a few long bristles. Scutum shining, black, almost without luster. Eyes covered by hairs.

31 (32). Tergite IX triangular, with rounded apex (Fig. 26).....3. A. aethiops Goet.

32 (31). Tergite IX with wide posterior margin.....
.....2. A. pavidus Winn.

33 (30). Antennal tuft reaching or practically reaching apex of antennae. Scutumn with gray luster. Eyes bare.

34 (35). Wing length approximately 2 mm.....
.....6. A. orbicularis Kieff.

35 (34). Wing length 1.4-1.7 mm.

36 (37). Proboscis curving forward. Scutum with long hairs (approximately 0.05 mm) ....4. A. lucorum Mg.

37 (36). Proboscis almost straight. Scutum with short sparse hairs..... .....4. A. Oedemerarum Storå.

38 (29). Wings without macrotrichia on membrane.

39 (40. Proboscis slender, almost as long as the height of the head. Eyes bare. Body length approximately 2. 5 mm ..... 7. A. rostratus Winn.

40 (39). Proboscis considerably shorter than height of head.

41 (42). Body and wing length 1. 2-1. 3 mm; legs, palpi and halteres light yellow, scutellum with 2 bristles. Eyes bare.....14. A. minutus Mg.

42 (41). Body and wing length approximately 1. 5-2 mm; legs dark, yellow to brown; scutellum normally with 4 bristles.

43 (46). Wing length approximately 2 mm. Eyes entirely covered by hair.

44 (45). Antennae long, length of flagellum 1.15 mm; antennal segments not fused. Legs dark brown..... .....12. A. brunnipes Mg.

45 (44). Antennae short, length of flagellum 1. 05 mm; segments partly fused. Legs yellowish brown..... .....10. A. majusculus, sp. n.

46 (43). Wing length approximately 1.5 mm.

47 (48). Scutum with long hairs (0.05-0.07 mm). Eyes bare ..... 11. A. hirtidorsum, sp. n.

48 (47). Scutum with short hairs (shorter than 0. 05 mm).

49 (50). Legs yellow, halteres pure white. Antennal tuft yellow, antennal segments IV-X not fused..... .....13. A. longicalcar, sp. n.

50 (49). Legs brownish yellow or brown. Antennal tuft dark, sometimes with a golden luster. Halteres normally dirty white.

51 (52). Wing length 1. 5-1. 85 mm. Eyes normally bare.... ..... 8. A. fossicola Kieff.

52 (51). Wing length 1.2-1.5 mm. Eyes entirely covered by hair..... 9. A. infuscus Goet.

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CORRECTION TO PAPER BY KH. REMM.

Estonian species of the genus Atrichopogon Kieffer (Diptera, Heleidae), I. Subgenus Psilokempia Enderlein. (Entom. obozr., 38(2):682-692).

Atrichopogon nanus Macfie, 1940 [Proc. R. Ent. Soc. Lond. (B), 9:184] and A. nanus Remm, 1959 (Entom. obozr., 38(2):686) are homonyms, as has been kindly pointed out to me by E. S. Pelham-Clinton of the Royal Museum of Scotland and by Dr. Clastry of the Pasteur Institute, Algiers. I wish to thank these colleagues and to rename the latter species A. paulus, nom. n.

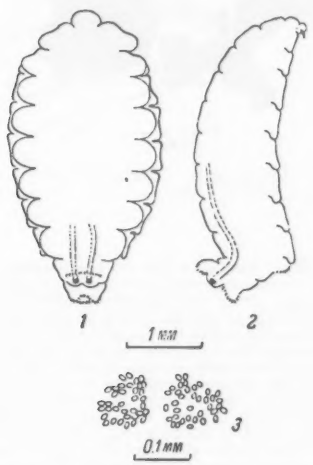
ON THE LARVA OF THE KANGAROO BOT FLY (TRACHEOMYIA MACROPI FROG.) (DIPTERA, OESTRIDAE) FROM AUSTRALIA

K. YA. GRUNIN

Oestrus macropi Frog. was described by Froggatt in 1913 from a 3rd instar larva taken from the mucous-membrane of a kangaroo trachea. A special genus, Tracheomyia Townsend, was soon established for this species (1916).

The discovery of T. macropi Frog. was very interesting for a number of reasons. Not only is it the only bot fly endemic in Australia; it is also the only bot fly parasitic on wild animals on that continent. Secondly, it is the only bot fly specific to the kangaroo genus Macropus Shaw and to marsupials in general. Thirdly, its localization in the host trachea is the sole instance of such a phenomenon in the family Oestridae.

In view of the small size of the larvae described by Froggatt, and the fact that none of the numerous larvae available to him pupated, it was suggested that he had described the species from 2nd instar larvae (Townsend 1938). The 3rd instar larvae of T. macropi Frog. show a similarity to the 2nd instar larvae of the sheep bot fly (Oestrus ovis L.) as regards body size and the squamate, apically serrate spines. This fact, taken in conjunction with the extremely unexpected discovery of an endemic bot fly in Australia, suggested to me that the reason for the description of T. macropi Frog. might be random parasitism of a kangaroo by the sheep bot fly, which is widespread in Australia in association with sheep. Even after a female of T. macropi Frog. with a number of morphological peculiarities clearly distinguishing it from species of the genus Oestrus L. had been described (Paramonov, 1953), justification for erecting the genus Tracheomyia Town – remained dubious (Grunin, 1957). My own doubts were finally dispelled after I had studied the 2nd and 3rd instar larvae of T. macropi Frog., on which this paper is based.[1] The external structure of these larvae is briefly described below.



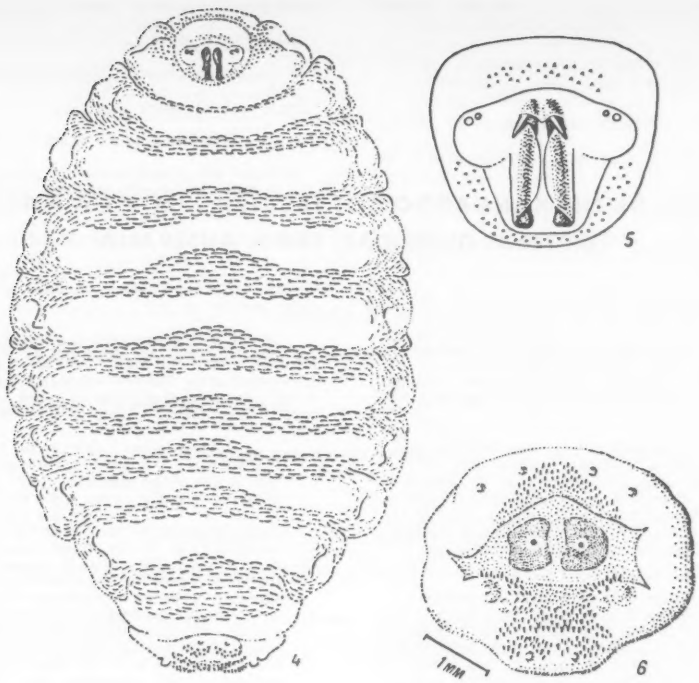
Figs. 1-3. - Tracheomyia macropi Frog. 2nd instar larva: 1 - general appearance, dorsal view. 2 - the same, lateral view. 3 - posterior spiracles.

The 2nd instar larva (Figs. 1-3) is semi-transparent, 4-5 mm long (as against the 6.5-8.0 mm length of the sheep bot fly). The ventral side of the body is flat, even concave; the dorsal side is convex. The segments are well demarcated, dorsally abruptly elevated above the flat lateral margins (Fig. 1); the 8th abdominal segment is narrow and turns obliquely upward (Fig. 2). On the ventral side the segments have the anterior margins bordered by numerous transverse squamate spines with apical denticles barely visible even under strong magnification. The height of the posterior spiracles is 0.1 mm and there are in all up to 40 respiratory pores on the surface of each spiracular plate (Fig. 3), whereas in the 2nd instar larvae of the sheep bot fly the height of the posterior spiracles is 0.33-0.38 mm and there are about 150 respiratory pores on the surface of each spiracular plate.

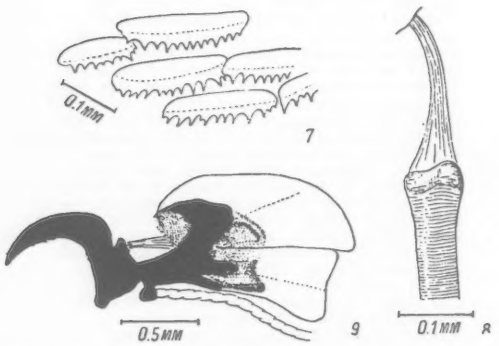
The 3rd instar larva (Figs. 4-9) is 7 to 14 mm long (sheep bot fly – up to 30 mm). The shape of the body resembles that of the 2nd instar larva but the longitudinal axis of the 8th abdominal segment coincides with the longitudinal axis of the body, so that the posterior spiracles are directed backward. On the ventral side there are zones of squamate spines along the anterior margin of each segment, from the 3rd thoracic to the 8th abdominal inclusive (Fig. 4); squamate spines with distinct denticles are present at the apex (Fig. 7). There are small spines, each with a single apex, on the anterior margin of the dorsal and ventral sides of the is thoracic segment, on the anterior margin of the dorsal side only on the 2nd thoracic segment, and on the posterior margin of the dorsal and ventral sides of the 8th abdominal segment (Fig. 6). The oro-pharyngeal apparatus clearly differs from that of the 3rd instar sheep bot fly larva (Fig. 10), and is appreciably smaller. The type of anterior spiracle structure is the same as in other representatives of the subfamily Oestrinae. (Fig. 8). The posterior spiracles are flat, closed cicatrix in the center of the spiracular plate. The height of the posterior spiracles is 0.62-0.71 mm (as compared with 0.92 to 1.65 mm in the 3rd instar sheep bot fly larva). The imago (female) of T. macropi Frog. is 9 mm long (Paramonov 1953) and is smaller than the adult of the sheep bot fly (10-12 mm).

The morphological differences both in the larva and in the imago of these two species justify referring them to different genera, but Tracheomyia Town. is undoubtedly close to Oestrus L. as regards both the wing venation and the armature of the 2nd instar larva. Nevertheless, we can completely exclude any possibility that T. macropi

[1] My sincere thanks are due to S. Ya. Paramonov and K. L. Taylor (Canberra) for their kindness in giving me an opportunity to examine these larvae.



Figs. 4-6. - Tracheomyia macropi Frog. 3rd instar larva. 4 - general appearance, ventral view; 5 - pseudosephalon and 1st thoracic segment; 6-8th abdominal segments, rear view.



Figs. 7-9. - Tracheomyia macropi Frog. 3rd instar larva. 7 - squamate spines; 8 - anterior spiracles; 9 - oro-pharyngeal apparatus, lateral view.

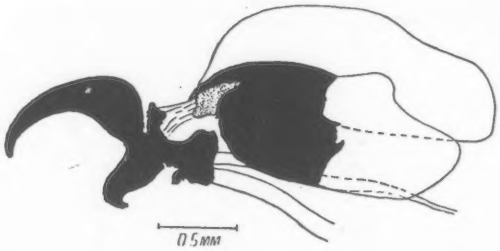


Fig. 10. - Oestrus ovis L. 3rd instar larva; oro-pharyngeal apparatus; lateral view.

Frog. has resulted from the transfer of the sheep hot fly, after its appearance in Australia in association with sheep, to the kangaroo. Sheep were not in fact introduced into Australia by the Europeans before 1788, so that the sheep bot fly cannot have been present in Australia longer than 125 years before T. macropi Frog. was discovered. Moreover, T. macropi Frog. is widespread in Australia and parasitic on several species of kangaroo. It is known from two points in New South Wales (Walgett and Tiboobura) and from two places in Western Australia, Roebourne and Woodstock, 160 km south of Port Hedland. The following kangaroo species have been mentioned as its hosts: Macropus giganteus Zimm. (Rodhain and Bequaert, 1916), M. rufus Desm. (Paramonov, 1953) and M. robustus Gould, (label attached to the material examined by me). Lastly, certain important morphological characters of T. macropi Frog. are undoubtedly primitive and significant as compared with the corresponding characters of the sheep fly and of the genus Oestrus L. in general. These include the squamate, apically dentate spines on the 2nd and 3rd instar larvae, which in the 3rd instar sheep bot-fly larva are replaced by spines of a different structure; the orbits without the crater-shaped depressions peculiar to Oestrus L. in the imago; the rudimentary labellum, which is not only retained but even split apically and is lacking in the sheep bot fly; and the less specialized wing venation (straight r_{4+5} attaining the wing margin fairly near the tip, and the distinct m_2). These characters can be regarded as relict features of Tracheomyia Town. which can be associated with the relict appearance of the Australian mammal fauna and in particular of this insect's actual hosts. The absence of simple ocelli in the imago

and the parasitism of the larvae in the host trachea are typical characters in relicts indicating extreme specialization (Rodendorf, 1946). In all other representatives of the family Oestridae, these characters are lacking.

I take this opportunity of correcting a common mistake. In November 1916, only a few months after the genus Tracheomyia Town. had been established, its name and author were mentioned in a paper by Rodhain and Bequaert (1916). This was the reason why in 1919 the erroneous indication "Tracheomyia Rodhain and Bequaert, gen. n." appeared in the Zoological Record for 1916. The mistake was repeated first in the Nomenclator animalium generum et subgenerum (Berlin, 1938) and then in the Nomenclator zoologicus (London, 1940). In both these publications Tracheomyia Rodhain and Bequaert appears alongside Tracheomyia Townsend; moreover, in the Nomenclator zoologicus the two genera are even referred to different families, the first to Muscidae and the second to Oestridae. Paramanov, (1953), not doubting the real existence of two different genera with the same name, merely noted that Tracheomyia Town. had been described a few months earlier.

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THE NINETIETH BIRTHDAY OF PROFESSOR I.V. VASIL'YEV

The 90th birthday of Professor Ivan Vasil'yevich Vasil'yev was on 6 October 1961. Professor Vasil'yev is one of the most outstanding applied entomologists in our country, an honorary member of the All-Union Entomological Society and a Doctor of Agriculture.

Ivan Vasil'yev began his scientific work in 1895 when a student at the Petersburg Forestry Institute, with an extensive study of the genital structure of longicorn beetles, and established the importance of these organs in the taxonomy of the group. On graduating from the Forestry Institute (now the Academy of Forest Technology in Leningrad) he entered the Moscow Agricultural Institute (now the Moscow Timiryazev Agricultural Academy), from which he graduated in 1901.

His wide training both in biology and in specialized branches of applied entomology (agricultural, forest and medical) equipped Vasil'yev to tackle the solution of a number of fundamental entomological problems.

His first work on applied entomology was concerned with sugar beet pests (1898). This work, which was broad in scope and which bore the stamp of a typically profound biological approach to its material, laid the foundation for subsequent research in this field and for the development of measures for the control of beet pests.

Vasil'yev did his first major work on Eurygaster integriceps Put. in 1904-1905; this research established the independent existence of this species, revealed the special features of its mode of life, and successfully initiated the biological method for the control of this important cereal crop pest by its parasite Microphanurus vassilievi Mayr.

Vasil'yev always had a wide range of interests in applied entomology. In 1908-90, he initiated study of lucerne pests and, in 1910, of the spider mite and the melon aphid. Between 1911 and 1913, he did outstanding work on the biology of malarial mosquitoes in relation to rice cultivation in Central Asia, and suggested effective control measures; the measures that he suggested during the initial stages of the research (intermittent irrigation, spraying with Paris green, and introducing viviparous Gambusia) were highly progressive, and had a great bearing on the reduction of malaria incidence among the population. Between 1913 and 1915, Vasil'yev made a detailed study of cotton pests in the main cotton region of Central Asia; this research provided the broad biological foundation for the development of measures to control the pests of this important crop.

Vasil'yev also made great contribution to the study of pests of new sub-tropical crops (the sesame pyralid), pests with quarantine significance (bean weevil), and weevils (pea weevil); and laid the basis for the development of biological control of weevils (using egg destroying forms).

Vasil'yev's contributions to the study of pests and control measures were vast. It is a particularly valuable feature of his work that he embodied his research results in excellent monographs which served as guides for the control of many pests in the most diverse branches of the economy: he published studies of the pierid butterfly (1901), the corn weevil (1907), lucerne tests (1908 and 1909), the melon aphid (1910), the eastern leaf beetle and the nut moth (1912), Eurygaster integriceps (1913), the pine moth and the cedar moth (1915), the apricot chalcid wasp (1915), cotton pests and 1917), and the malarial mosquitoes of Central Asia (1911 and 1913).

Since insect biology is one of the most rapidly developing branches of entomology, many works are soon outdated. Though many of Vasil'yev's works are fifty or more years old they have scarcely been affected: we still turn to them again and again, and still find valuable information which has not lost its importance even today, because they contain so many new and critically examined facts and new and progressive ideas.

The Presidium of the All-Union Entomological Society and the Editorial Board of "Entomologicheskoye obozreniye" (The Entomological Review) send their warmest greetings and sincere good wishes to Ivan Vasil'yevich Vasil'yev, the dean of pre-revolutionary and Soviet applied entomology, on the occasion of his 90th birthday.

The Presidium of the All-Union Entomological
Society and the Editorial Board of
"Entomologischeskoye obozreniye"

AN EXTREMELY SIMPLE MICROPROJECTOR FOR DRAWING INSECTS

K. B. GORODKOV

A microprojector of some kind is a most important aid to the research worker. There is nothing essentially new about my instrument, but it is clearly one of the handiest and simplest types in current use. Its use doubles or trebles output when drawing, and slightly increases the overall accuracy of the picture. Its application is, however, limited by the fact that it is only suitable for work with well illuminated objects in transmitted light. It also requires a microscope (such as the MBI-1) with an inclined barrel and a light source (a microscope lamp).

The microprojector should preferably be made from parts of the first model of the Soviet drawing apparatus (RA-1), discarding the hinged top that contains the prism and light filters; one can also use parts from other types of copying apparatus, or they can be specially prepared.

The microprojector (Fig. 1, 2) consists of a mirror (m) mounted on an arm (a), which is attached, in its turn, to the inclined barrel of the microscope by a bulldog clip (c) with a tightening screw (s). The screw of the barrel housing (s) on the right of the microscope is loosened to enable the inclined barrel to be moved to the right and then tightened. The mirror of the microprojector is tilted so that the image from the microscope is reflected perpendicularly onto the surface of the drawing paper; the setting can be checked by placing an eyepiece in the center of the illuminated circle. Its shadow should form a ring of uniform width around its base.

It is easiest to work with a long rod, since one can then manage without an inclined drawing board. It is particularly advantageous to use a microscope with an inclined barrel, since its position on the table is suitable for the research worker; the drawing space is to the right of the microscope; and the prism of the inclined barrel removes the need for a second mirror.

Since the image brightness is slight, the microscope can only be used in a darkened room, although it need not necessarily be in total darkness. Particular attention must be paid to the setting of the light, and the instrument cannot be used without an artificial light source. The rules for lighting are those normally used in microscopy, and it is best to adjust the light with the microprojector removed. The specifications for the light state: "the microscope stand is mounted on the board attached to the lamp, with the recesses in its base over the lugs on the board. The lamp is mounted on the other end of the board with its socket in the hole in the board. The lamp is therefore always at a fixed distance from the microscope.

"The slide is placed on the microscope table, and the

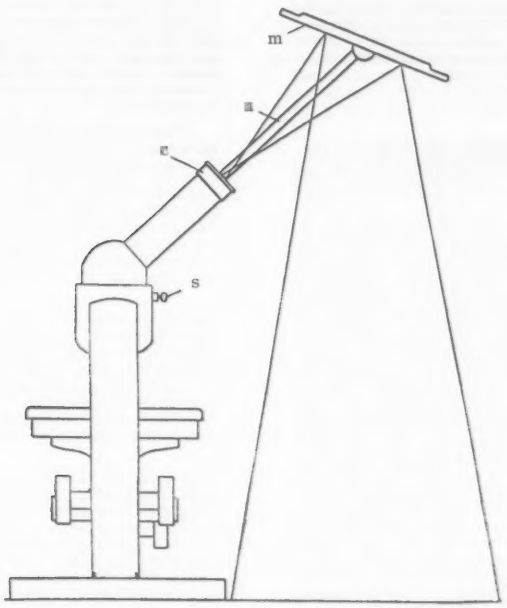

Fig. 1. - Microprojector in operating position. Explanation in the text.

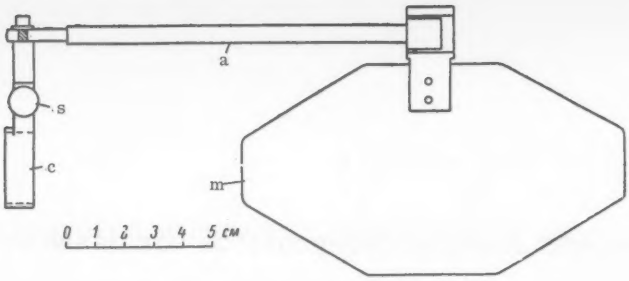

Fig. 2. - Microprojector, view from above.

microscope is focussed until a sharp image is obtained. The lamp is then rotated on the bracket until the beam of light falls on the center of the mirror. One must then move the lampholder until the filament of the lamp gives a sharp image on the closed iris of the condenser diaphragm of the microscope.[1] One must next open the condenser diaphragm, close the lamp diaphragm and adjust the condenser, looking into the microscope, until the sharp image of the lamp diaphragm is in the visual field of the microscope.

"The image of this diaphragm must then be brought into the center of the field of vision by rotating the mirror, and the lamp diaphragm opened to a point at which only the visible field of vision is illuminated. How far open the condenser diaphragm should be is a matter of practice. The diaphragm is usually opened gradually to reveal the greatest possible detail combined with good contrast and adequate lighting".

I have already stated that unless these rules are followed it is impossible to use the microprojector.

The rheostat is usually adjusted to give maximum filament voltage. When the magnification employed is less than 40 the upper lens of the condenser must be adjusted. I have only used an OI-19 lamp (and earlier models); the more powerful OI-20 lamp may be better. The over-all dimensions of the image are often important in relation to the format of the drawing. If the normal magnification of the microscope is insufficient, it is best to use replacement lenses and eyepieces (the optical parts of old microscopes are often suitable), and less satisfactory to raise the drawing above the table or to draw without an eyepiece. The magnification of the drawing is established with a micrometer gauge, the scale of which is reflected on the paper. There is scarcely any distortion round the edges of the illumination field. Like a copying machine, the microprojector fails to reveal the finest detail; when adding in details, one must remove the microprojector or, preferably, replace the barrel by a binocular mounting.

The microprojector is most useful for drawing many objects, including the genitalia of Diptera, Lepidoptera and other insects, and total and partial mounts of small Hymenoptera, etc; in general, one can draw not only insects but any small and sufficiently transparent subject (radiolaria for example). Permanent mounts are not essential although they are very convenient. One can draw insects in glycerin in a saltcellar (preferably with a polished base, although this is not essential). They can be fastened by micro pins stuck into wax at the edges of the base. Fixed mounting of the specimen is quite essential. One often has to place the mount in a hot gelatin solution in the saltcellar. As this sets, the specimen is given the required foreshortening. If a cover slide is placed on top of the gelatin, drying out is slowed down. The gelatin can later be removed from the specimen in warm water. It should be remembered that temporary mounts of this type cannot be kept for long and that drying out may spoil them. The number of ways in which a specimen can be mounted is clearly limitless, and will depend on the nature of the material and on the preference of the investigator. Finally, if one is only concerned with the contours of a given part of the body (for example the antennae) or the venation of a transparent wing, dissected insects can be drawn in a dry state. The microprojector can be used for microphotography, if a film or plate is placed on the tube.

In conclusion, I hope that industrial production of even primitive microprojectors, possibly using parts from the RA-4 copying apparatus, will be widely arranged in the USSR.

[1] The filament image of the bulb can be focused on the microscope mirror by placing a piece of paper on it (K. G.).

REVIEWS AND BIBLIOGRAPHY

MATERIALS ON THE PROBLEM OF DENDROLIMUS SIBIRICUS TSCHTV.

G.A. ZINOV'YEV

Izd. Sibirsk. otd. Akad. Nauk SSSR, Novosibirsk, 1960:1-136.

This is a collection of eleven papers prepared for discussion at a special symposium in Novosibirsk (19-21 December 1960).

The over-all results of many years of field study of Dendrolimus sibiricus Tschtv. in Western and Eastern Siberia, in the Chita region and in the Far East, are set out in considerable detail in papers by V. O. Boldaruyev, L. A. Ivliyev, N. G. Kolomiyets, V. N. Naumova and A. S. Rozhkov. Consideration is given to factors favoring increase in numbers and mass outbreak, and the greatest importance is attached to the dryness of the summer, especially May — June and July. Extensive outbreaks are usually preceeded by 2-3 years of drought. The viability and fertility of the moths are improved by the increased summer temperatures, but the most important factor is the transition of the moth to a one year development cycle. There is also a great increase in the number of suitable breeding sites during droughts. Cold winters with little snow apparently also favor an increase in Dendrolimus sibiricus Tschtv., since the principal parasite of its eggs (Telenomus gracilis Mayr.) is far less able to withstand the cold than are the caterpillars (Kolomiyets). It is noted that mass outbreaks are associated in some localities with ragged and unplanned felling, and especially with slash fires. The climatic and biological indications of threatening periods and districts are also examined: thus, throughout the area of Dendrolimus sibiricus, increases in the numbers of various common pests (the pierid butterfly, gipsy moth, satin moth, etc.) apparently indicate a possible outbreak (in the following year).

The threat of mass outbreaks is rather infrequently realized, and a rise in the numbers of the insect may be checked either at the beginning or at its height. Thus, the increase may be rapidly eradicated by colder damp weather. In addition to weather conditions, increase in numbers may be checked by such factors, as, parasites, predators and diseases, and by the over-all richness of the biocenosis (Ivliyev).

The book gives new facts on a number of other questions, including the importance of entomophages and diseases in extinguishing mass outbreaks, overwintering conditions for the caterpillars, and phenological features in different foci and under different climatic conditions. The importance of a change in the number of generations, by transition to a 1-year cycle or by extension of development, is particularly stressed.

The papers of A. S. Rozhkov and N. G. Kolomiyets announce the results of research on some of the physiological features of Dendrolimus sibiricus caterpillars (especially the significance of individual food items, and the importance of the formed elements of the hemolymph and fat body in relation to resistance to poisons); and reveal the dynamic features of resistance in the caterpillars. New chemical poisons (aldrin, dieldrin, chlordane etc.) were tested in addition to old poisons.

Kolomiyets sums up the results of field research in Western Siberia in his typology of mass outbreak foci (concentric plain, low mountain chain and mountain bastion foci. Certain general features are shown to exist in the preference of Dendrolimus sibiricus — especially in primary foci — for certain types of forest and relief. Thus, primary foci are almost everywhere associated mainly with mountain slopes and the tops of flat watersheds. These features make it possible to work out suggestions for improving our check on the increase of Dendrolimus sibiricus.

The paper by G. I. Galkin on the reservoirs of Dendrolimus sibiricus in the Krasnoyarsk subdistrict deals with features in their formation, and the population dynamics of Dendrolimus sibiricus within them; these questions are also considered by Kolomiyets, and in the paper by Naumov on foci in the Chita region. Their facts finally refute all attempts to explain sudden outbreaks of Dendrolimus sibiricus by mass incursions from old outbreak foci: the overwhelming majority of the foci are local and not migratory.

Practically every paper touched on the scope for the use of entomophages in control of Dendrolimus sibiricus, and the paper by V. O. Boldaruyev and Z. P. Pozmogova is devoted to a special attempt to colonize Telenomus on a semiproductive scale. Unfortunately this work was conducted without reliable control calculations.

Although there is a great deal of information on the importance of various entomophages in some sectors of their areas, there has been exceptionally little study of the biology and ecology of the main parasites of Dendrolimus sibiricus (except for Telenomus), especially in reservoirs of the pest. Nevertheless, even such an apparently simple technique as the collection of parasites in old foci and their transference to the developing foci calls for a knowledge of the epizootic state of the foci over a wide area (Kolomiyets). Further development of the principles for using entomophages and detailed scientific justification of actual control measures are therefore essential. Until this has been done it will not be possible to suggest the productive introduction of the biological method. Boldaruyev justifiably suggested that we should set up at least one modern laboratory devoted to the biological method (this should actually be a laboratory to deal with the ecology of Dendrolimus sibiricus). It should also be added that it is equally important to provide new specialists for groups working on the biological method of control.

One should also support Rozhkov's proposal that there be a special commission (or working group G. Z.) on Dendrolimus sibiricus under the jurisdiction of the Siberian Department of the USSR Academy of Sciences.

It is good to note the perceptible increase in the work on the diseases of Dendrolimus sibiricus (papers by A. V. Gukasyan, V. I. Poltev and Ye. V. Talalayev). In particular, Gukasyan's research has embraced the microflora of the caterpillars, pupae, imagines and eggs of Dendrolimus sibiricus; its parasites; coniferous needles and underbrush in the foci; investigation of the part played by the microflora in the life of the insects; and testing of isolated pathogenic cultures and preparations. Poltev's group at the laboratory of Insect Microbiology (Novosibirsk) has tested a number of streptococci as pathogens for Dendrolimus sibiricus (Streptoccoccus apis, S. bombicis and S. dendrolimus) non-spore-forming bacteria (Bacterium prodigiosum), bacteria from diseased Dendrolimus sibiricus caterpillars and spore-forming bacteria (various strains of Bacillus thuringensis, B. cereus var. alesti, B. cereus var. galeriae and B. dendrolimus,) obtained from various institutes or isolated from infected caterpillars of the Siberian and oak silkmoths, other moths, and flies and bugs. It has been shown that spore-forming bacteria are considerably more virulent than non-spore-forming bacteria, and that crystals formed during sporulation have a toxic effect on the caterpillars of Dendrolimus sibiricus. The connection between dissociation in nutrient media and bacterial virulence has been studied.

Particular attention is paid to elaborating principles for the use of the most active strains of Bacillus dendrolimus (Talalayev) and B. dendrolimus var. sibirica[1] (Gukasyan), dry preparations of which were made at the First Moscow Bacteriological Plant and tested under both laboratory and field conditions, including tests on a productive scale. All the tests show that these preparations are exceptionally virulent in relation to Dendrolimus sibiricus caterpillars, although no stable epizooty was produced (Gukasyan, Poltev). Talalayev, who is responsible for the method, continues to insist that there may be secondary infection of the caterpillars (i. e. infection of healthy caterpillars, not by eating the preparation, but from previously affected caterpillars). In Gukasyan's opinion, the spread of the infection is hindered largely by the phytocidal activity of pine needles. Nevertheless, Poltev established by tests that the effect of undamaged pine needles from all trees studied was so weak that the factor could not be of importance under natural conditions and the absence of secondary infection was due to the fact that the caterpillars only perished on eating large doses of bacteria (not less than 100,000), while at doses of up to 36,000 bacteria there were no observable pathological changes. Such concentrations can only be achieved in primary infection, when the forest is plentifully sprayed with the microbe preparations.

Tests with large-scale production of these Talalayev and Gukasyan strains were made by spraying or dusting the foci (areas of 40-50 ha), and these authors consider that the results justify them in recommending the microbiological method. During a year of treatment, caterpillar mortality reached 95.6% (Gukasyan; in the controls 6. 8%) or varied between 20 and 90% (Talalayev); in the latter case the mortality of pupae and caterpillars in cocoons in the following year was 36-75%. Nevertheless, the information given in the papers does not convince one that the infection took hold in an outbreak focus of Dendrolimus sibiricus. Also, Talalayev's selection of the areas for testing the method was unsatisfactory, since it was impossible to distinguish between the test areas and adjacent areas also infested by Dendrolimus sibiricus. Moreover, three of the four villages chosen as controls were in the region to which the wind carried the preparation. It should be mentioned that it is absolutely essential to observe experimental and control foci for 2-3 generations and not only for a single year. No analysis is provided of other factors responsible for mortality in caterpillars and pupae, although there are published data (Kolomiyets and Gukasyan) for the accumulation of a septicemia agent in the pseduopupae and imago of Parasarcophaga ulifinosa Kram. and other species of the Sarcophagidae, and this would lead one to pay particular attention in microbiological studies, to the nature and significance of other enemies of Dendrolimus sibiricus among the Coleoptera and Diptera. It is also essential to allow for the effect of entomophages both on the course of epizooty and on the fate of the reserve total of the pest.

[1] Poltev, who made a bacteriological study of Gukasyan's dendrobacillin, did not recognize a culture obtained from it as Bacillus dendrolimus var. sibirica, although he stressed its great virulence (in company with entobacterine) for the caterpillars of Dendrolimus sibiricus in tests in parks and in the forest, and also stated that the preparation was harmless to bees.

A paper by G. O. Krivolutskaya is devoted to the fate of timber stands damaged by Dendrolimus sibiricus, especially the role of wood-boring pests in the West Siberian foci; the same questions for the conditions of the Far East are touched on by Ivliyev. The group of wood-boring pests has been studied and the sequence, periods and nature of their infestation of fir, spruce, cedar and larch has been established; Krivolutskaya has categorized the types of infestation (three types for each species of tree). There is an examination of the infestation and population dynamics of the main pests, their companions and enemies; during three years of observation on permanent sample areas in dark coniferous forests it was found that bastion foci of Dendrolimus sibiricus are quite slowly and gradually infested by bark beetles and longicorn beetles. On the other hand trees become rapidly infested in stands in which all the trees have been attacked in continuous foci and the area of the primary focus gradually extends; the development of wood-boring pests in Dendrolimus sibiricus areas usually ends in the 3rd or 4th year.

In my opinion it is a fault of work on wood-boring insects that no comparison has been made of the nature of tree infestation and the population dynamics of insects in Dendrolimus sibiricus areas and their dynamics in healthy stands, on the one hand, and in felled areas and timber stores, on the other. In the absence of such a comparison, it is difficult to estimate the accuracy of our knowledge of the infestation of Dendrolimus sibiricus areas, and thus to give a scientific understanding of their fate and possible use.

In conclusion it must be stressed that the faults noted in certain articles do not detract from the considerable value of all the material that they contain; on the other hand the problem of Dendrolimus sibiricus is of such importance to the national economy that one must set particularly high standards. The papers in this collection do not cover all the trends in research on Dendrolimus sibiricus in the USSR. Nevertheless the over-all impression is clearly correct — namely that further accumulation of descriptive materials on the biology and ecology of Dendrolimus sibiricus and its enemies (which is quite justifiable and essential) is being combined with a more profound experimental study of its physiology and ecology. It is evident that experimental physiological research must be greatly expanded, and it is most important that laboratory work be combined with field observations and tests. It must be stressed that research on Dendrolimus sibiricus should not be geared to the course of mass outbreaks. Quite apart from its economic importance, the problem of Dendrolimus sibiricus is an interesting case of the general theoretical problem of mass multiplication, and every intensification of this aspect of research on Dendrolimus sibiricus is therefore extremely desirable.

It is to be hoped that the extremely successful method of holding discussions on previously circulated papers will become firmly established in the Siberian Department, in the Academy of Sciences as a whole, and in other establishments.

REPORT OF THE SEVENTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE

(6-15 JULY, 1960)

Commonwealth Institute of Entomology, London, 1960

M. A. BULYGINSKAYA

Entomological conferences of the countries in the British Commonwealth are convened approximately every five years. The object of these conferences is to discuss scientific problems in agricultural entomology, to assess the work of entomological institutes and the work in biological control jointly financed by the Commonwealth countries.

The Seventh Entomological Conference, which was held in London between 6 and 15 July 1960, was attended by 56 delegates from 21 countries. All the papers read at the Conference have been published as a supplement to the Minutes and Resolutions.

The Conference heard reports from the directors of institutes of entomology and biological control on the work of their institutes between 1954 and 1960.

The Director of the Commonwealth Institute of Entomology (Dr. E. O. Pearson) gave details of the Institute's extensive work on the identification of insects. Between six and eight thousand species are identified annually. A great many of the identifications are made for countries in Africa (approximately 3-3.5 thousand annually) and Asia (1.5-2 thousand annually). Between 1954 and 1960 54, 669 insects were sent to the British Museum of Natural History, including the type specimens of 678 new species and 1490 species that had not previously been in the Museum's collection.

The monthly publication of the Review of Applied Entomology is one of the important aspects of the Institute's work. The Institute is also responsible for the publication of the Bulletin of Entomological Research, Zoological Record (Insecta), distribution maps of pests, and various other publications.

The Director of the Institute of Biological Control (F. J. Simmonds) noted the increasing part played by the biological method in the control of a number of insects (such as the apple worm in temperate latitudes and Aeneolamia spp. in the tropics), which develop resistance to various insecticides. The importance of the microbiological method has recently been on the increase. Commercially produced spores of Bacillus thuringiensis have been used against a number of pests and are an "insecticide" that is not toxic to mammals and useful insects (predators and parasites). On the other hand this preparation does not have a long-lasting effect, and it is comparatively expensive. Development work is being done on the use of viruses against certain pests of cruciferous plants, and of parasitic Coelomomyces fungi against blood-sucking mosquitos.

Much work has been done in recent years in evaluating the activity of individual species of parasites and predators on insect populations of local species. The possibility of using various genetic and geographic populations of parasites and predators is also being studied. Simmonds also gave figures that illustrated the work of the Institute on the acclimatization of useful species. In the past five years a million and a half useful insects and birds have been despatched to 26 countries in 1650 consignments for use against 35 harmful species (including weeds).

The Institute and its branches are also working on the taxonomy of various groups. The European station is working on the taxonomy of the Tachinidae, Chalcidoidea, and Proctotrupoidea; and Trinidad is working on the Encyrtidae. Extensive links are being developed with other countries including Canada, Czechoslovakia, the USSR, Poland, Bulgaria and the USA.

The Australian delegate, F. Wilson, presented a lengthy paper on the future of the biological control method. He dealt with the negative effects of chemical control, which increases the numbers of other pests, converts some neutral species into pests, destroys pollinators, leads to the appearance of races resistant to insecticides, and to the accumulation of toxic residues in the soil and, in the end, to a direct threat to man and to useful animals. Insecticides also have a marked effect on the relations of species in the biocenosis. Wilson also dealt with the scope of the biological method in Australia, where it is mainly used for the control of accidentally introduced harmful species.

A number of papers were devoted to recent advances in the use of insecticides. F. T. Martin spoke of difficulties associated with the use of the new insecticides, which often affect the natural balance between useful and harmful organisms. An example is provided by the mass outbreak of red mite on Australian apples, owing to suppression of its natural enemies. In Italy the house fly has become DDT resistant. The destruction of useful organisms, and the development of resistance in insects of medical and veterinary significancce, are together becoming a serious problem. Great attention was therefore paid to questions of this nature at the Conference. Dr. Martin described the new insecticides and indicated their advantages and drawbacks. He suggested that insecticides be classified by toxicity, established by oral administration of the poison to rats.

	LD 50%	
mg/kg	mg/kg	mg/kg
1a—up to 50	2a—100-300	3a—500-1000
1b—50-100	2b—300-500	3b—above 1000

Insecticides in Groups 1a and 1b are very dangerous to man and should not be used. When assessing the toxicity of insecticides one must allow for possible inhalation and the extent of cutaneous adsorption. A compound may be highly toxic (belong to Groups 1a or 1b) but poorly adsorbed by the skin, or, on the other hand, it may be moderately toxic (Groups 2a or 2b) but may penetrate through the skin rather easily.

A. B. Hadaway stressed the need for a good knowledge of the biology of a species for the correct use of insecticides. J. M. Barnes reported in his paper that extreme caution is necessary with all the pesticides in current use. Cases of death and severe illness have been reported from various parts of the world as a result of poisoning by pesticides: deaths have been reported from the following poisons — parathion (pholidol), demeton, TEPP, DNOC, pentachlorphenol, dieldrin are especially dangerous.

The Conference paid particular attention to the virus diseases of plants, and their vectors. A communication from Dr. M. A. Watson gave some interesting information on the relationship between effective transmission of the tobacco leaf mosaic virus and the length of time for which Myzus persicae Sulz. had been feeding on the plants. When this aphid has been first starved, and then fed on tobacco for two minutes, it transmits the infection to other plants better than specimens that have fed on tobacco for 24 hrs.

Viruses can survive for a long time in the alimentary canal and blood of beetles, but J. H. Freitag (1956) has

found that the mosaic virus does not survive the pupation of the insect vector. Viruses are usually destroyed by enzymes, or voided with the excreta, in the case of the pupae of insects with complete metamorphosis. This is perhaps the reason so few plant viruses are transmitted by such insects. Watson also gave examples of races with differing transmissive capacities among insect vectors of viruses.

Dr. A. F. Posnette dealt with cases of the transmission of viruses from local plants to cultivated plants. Cocoa is not a plant that is indigenous to West Africa, and there can be no doubt that the three viruses that cause diseases in this plant are spread to it from wild trees, on which they have been found quite far from cocoa plantations. Two of the three viruses are spread by mealybugs, Pseudococcus spp; the vector of the third virus that causes cocoa blight has not yet been discovered. Pseudococcus spp., in their turn, may be spread either by the larvae being carried by the wind or by being transported for short distances by ants (Crematogaster spp.). Spraying with dieldrin reduces the number of ants and thus lowers the diffusion rate of the viruses.

J. S. Kennedy announced the results of laboratory tests on the spreading of viruses by aphids. It has been established that more than 180 species of the Aphidoidea can transmit approximately 160 different viruses.

Some papers dealt with the locust problem. L. Waloff (Locust Research Center) reviewed the breeding of three species of gregarious locusts (Locusta migratoria migratorioides, Nomadacris septemfasciata and Schistocerca gregaria) between 1887 and 1958. During this period there were only two mass outbreaks each of L. migratoria migratorioides and N. septemfasciata, that lasted for 15 to 18 years and were separated by approximately 20 years of depression (in the case of N. septemfasciata) and 24 years (in the case of L. migratoria migratorioides). The picture is quite different for the desert locust (Schistocerca gregaria), which shows frequent short term increases in numbers; the peaks in the last 50 years having been reached in 1915, 1930, 1944 and 1953-1955. The breeding of this species is highly seasonal, and closely related to weather conditions in various parts of its vast area, which embraces the whole of the northern half of Africa, Arabia, South West Asia and India. This gives rise to new thoughts on the tactics of control of this species of locust.

P. T. Haskell and R. C. Rainey presented papers on the biological principles of locust control and on recent advances in control techniques.

A large part of the book consists of reviews of agricultural entomology in the countries of the Commonwealth.

MOSQUITOES OF MEDICAL IMPORTANCE

By: R.H. Foote and D.R. Cook, Agricultural Handbook No. 152:1-158, Washington, 1959.

A. V. GUTSEVICH

The book contains a very brief introductory study of the role of mosquitoes as vectors of malaria, filariasis, yellow fever, dengue, encephalitis and other virus infections. The major part of the work consists of information concerning mosquitoes, presented separately for each geographical region. Thirty-eight such regions are distinguished, those in Eurasia, for example, being: Northern Europe and Northern Asia, Spain and Portugal, Italy and the Balkans, etc. The section dealing with each geographical region consists of 2-3 pages of large type and 2 plates. The geographic information and data on the most important vectors (biology, geographic distribution, medical importance) are given in an extremely brief telegraphic style in the text and accompanied by two pages of drawings (pictorial keys); there is no key in the text. Each table contains diagrams of the adult mosquitoes and the larvae, with the parts of the body labelled; and separate drawings of the features of structure and color by which the given species may be identified. Although the drawings are diagramatic, they are very clear and well executed, and have detailed labelling and notes. They could be used by someone without special training.

At the end of the book there is more detailed information on the biology and medical importance of mosquitoes (by genera and species), a bibliography (350 entries), a glossary and an index. Throughout the text, references are indicated by their numbers in the bibliography.

Particular attention is paid to mosquitoes that are malaria carriers. Only a few of the nonmalarial mosquitoes have been included. Some species that are important vectors of filariasis or virus infections in some countries are not included in the key for indentification, although they are covered by short notes in the text. The "visual key" contains 106 species of mosquitoes including 85 species of Anopheles.

It must be acknowledged that the book is extremely useful especially for practical workers. The "visual keys" would not, of course, satisfy specialists. The concept "species of medical importance" is also quite arbitrary: those who use the book for identification will not, of course, have prior knowledge of whether a given mosquito is of medical importance. Nevertheless, even the specialist will find much that is useful in the book. It provides a rapid reference to the most important species of mosquitoes and to their biology and medical significance in any region of the earth and also indicates the literature for more detailed study.

It has to be mentioned that the authors have made very little use of the Soviet literature. The information for the Soviet Union is very sparse. There are also inaccuracies and occasional mistakes, one of which concerns the distribution of dengue and its vector (p. 63). Much of the information is also greatly out of date (this applies, for example, to the distribution of malaria in different countries).

There is no similar handbook for practical workers in Soviet entomological literature, although such works are very necessary in relation to certain groups of insects. Thus, in connection with great developments in the control of swarms of midges, we certainly need to compile, for the separate geographical zones of the Soviet Union, a simple key (or series of keys) for the identification of the most important species of blood-sucking Diptera.

STUDIES ON SCANDINAVIAN EPHYDRIDAE (DIPTERA, BRACHYCERA)

R.G. Dahl, Opuscula Entomologica, Suppl. XV, Lund, 1959, pp. 224, 1 Map

E. P. NARCHUK

Dahl's work on the Scandinavian Ephydridae is extremely interesting and comprehensive. Some of the Ephydridae inhabit extremely distinctive types of biotope; the larvae of some species live in waters with a very high salt content, in hot geysers, in oil pools, and in accumulations of guano. Dahl has studied the many Ephydridae that live in biotopes regulated by average ecological factors. His work is different districts throughout Scandinavia continued for five years (1954-1958). It included field observations; experimental studies of the importance to the imago of temperature, humidity and salinity; and morphological research mainly for taxonomic ends.

His approach in this book is extremely broad. The material is arranged in seven chapters grouped into three sections: ecological studies of the flies in the field; experimental research; and morphological study for taxonomic ends.

The last chapter contains observations and comments that have not been included under these main headings. It is therefore somewhat mixed and has a long title: "Some notes on biology, phenology and geographic distribution".

The author did his most intensive field work in Southern Sweden, but also made some observations on the northern coast of Norway, where the environmental conditions for the Ephydridae differ greatly from conditions in southern Sweden. When studying the habitat of the Ephydridae, he selected an ecological series of biotopes in the coastal belt complex along the sea shore, and a similar series along the shores of fresh water lakes. Biotopes that were added from outside these series included waste land and various types of meadow. The ordinary simple method of counting (50 sweeps of the net for each sample) was used in the field work. Mention should be made of an interesting and quite simple attachment that was used when collecting Ephydridae in two-dimensional biotopes, such as various types of meadow, water-lily and duckweed beds, and the sandy beaches. All except the deepest part of the net was replaced by a fine-holed metal grid, so that part of the hoop of the net could go into the water or sand without harming the flies.

The quite detailed description of the biotopes studied, given in Chapter I, indicates microclimatic conditions, higher vegetation and, in a number of cases, algae, which were specially collected by the author. Attention was paid to algae because they provide food for many Ephydridae. A list of the common species is given for each biotope and the dominant and constant species are indicated. Dominance was considered in relation to all the Diptera Brachycera, collected in the given biotope. It was found that one of the genera Scatella, Ephydra and Notiphila was dominant in each of the three types of biotope. Flat biotopes from which higher vegetation is almost totally absent are associated in the main with sandy beaches; here Scatella species dominate. In another type of biotope, characterized by the large plants that surrounded water (rushes and ecologically similar species) Notiphila species predominate. Biotopes of the third type with an expanse of open water are inhabited by Ephydra species. Chapter 4 gives the results of research on the morphological adaptations of flies to life in such different types of biotope. Dahl studied adaptive characters in the structure of the legs, the female abdomen, the mouth parts, and the shape of the eggs. Unfortunately he did not study larvae at this level, although this would certainly have yielded interesting material.

His examination of a large number of biotopes with different temperature, humidity and salinity conditions enabled Dahl to distinguish xerophilic, mesophilic and hydrophilic species associated with lake and sea shores. It must be said that his conclusions on the salinity factor are extremely cautious. He will return to this question after experimental studies.

The practical procedure for experiments with small Diptera is quite difficult. The fact that often the species can not be identified before the experiment has the effect of limiting the number of specimens that can be used in tests, since each experiment has to be separately processed. Dahl showed great ingenuity in his experimentation. He used more than ten different devices for his experiments. His most detailed studies were of the basic environmental factors of temperature, humidity and salinity. The preferred level of the factor was separately determined for each of the most accessible species, and its resistance to extremes was also tested. This applies in particular to the effect of salinity. When studying the importance of this factor for species confined to the sea coast, Dahl found that only Ephydra riparia, Scatella subguttata and Hecamede albicans (among those that he studied) can be said to be halophilous. The majority of the species studied showed no positive reaction to the salinity factor although they are usually found on the shore. Dahl thinks that one can reject the terms halobiont and halophile in their normal sense. Of all the species studied, only the three already mentioned are, in his opinion, truly halophilous. Salinity does not play a direct role in their connection with sea coasts but is of importance for the halophilous microalgae on which the ephydridae feed.

It is interesting to note that temperature and salinity are mainly of importance as "edaphic" factors for Ephydra riparia; that is, connected with the surface scum on waters. Ephydra riparia prefers relatively low temperatures (preferred range below 20°C) and high salt content. Both these factors at these levels considerably enhance surface tension, and thus create the most favorable conditions for movement.

The taxonomic section is prefaced by a brief account of the study of the Ephydridae in Scandinavia and of information on the development of classification within the family. The use of new characters in taxonomic work plays the same role as the introduction of a new method in scientific experiments. In order to provide a basis for classification within the family, Dahl studied three groups of characters, which had previously been entirely neglected or little studied for taxonomic purposes: the structure of the male genitalia, the structure of the female abdomen (especially the shape of the 8th sternite) and the structure of the proboscis. His first undertaking was an extensive study of the male genitalia; he investigated the hypopygium of 35 Ephydridae species. His proposed division into subfamilies, which seems quite well founded, is based on these characters plus chaetotaxis and ecological data.

The taxonomic list of Scandinavian Ephydridae contains 93 species (excluding species of the genus Hydrellia R. -D., which Dahl did not study, since its taxonomic position is very confused and exact identification is almost impossible). The main synonyms, references in the literature (taxonomic, biological and pre-imaginal stages), main taxonomic characters, ecological and biological data and geographical distribution are indicated for each species. Two of the species are described for the first time.

The final chapter summarizes observations on the behavior of the flies under field conditions. There is a brief description of behavior when feeding, in defense, and when mating. There is a brief examination of phenological groups based on the flight period of the flies under natural conditions. In the account of geographic distribution, particular significance is attached to the climatic factor, which restricts the distribution range.

The author cannot be reproached for not having studied the larvae of the Ephydridae. Nevertheless, total disregard of available information on larvae seems somewhat unfortunate. It is to be regretted that Dahl did not draw on well known data for the pre-imaginal stages, when considering the division of the genera into subfamilies, and in Chapter 4, where he considers morphological adaptations to various types of habitat.

The author's division of the genera into subfamilies is based on his study of the male genitalia, but his brief descriptions of the genitalia seem a little derivative, since they are never accompanied by drawings or diagrams. This is all the more incomprehensible since the structure of the proboscis and female abdomen is shown in drawings in similar cases. Unfortunately, the majority of the drawings are rather too diagrammatic, and in some cases essential details are too small; for example, the 8th sternite in the drawings of the female abdomen. Even in his descriptions of the new species, which are extremely short, there is no drawing and no description of the male genitalia, although the author had sufficient material for Scatella lindbergi.

Dahl used two methods in his research on preferred temperatures, but it is difficult to compare the interesting experiments with an "activometer" and the previous experiments, since they were conducted mainly on different species.

In my opinion, the author is sometimes led to false conclusions by a desire to explain everything that he has observed. Thus, we can scarcely agree that, when the shadow of a large object falls on Scatella as it runs along the sand, there is a clear defense reaction, as against a predator (in this case an insect-eating bird); especially since he states a little further on that birds mainly eat the preimaginal stages.

These remarks in no way detract from the great value of the book, which will certainly be extremely useful both to dipterologists and to all others who have to conduct experiments with small subjects.

THE MITES OF STORED FOOD BY A.M. HUGHES

Technical Bulletin No. 9, Ministry of Agriculture, Fisheries and Food, HMSO, London, 1961:I-VI: 1-287

N. G. BREGETOVA

The damage done by many species of mites to stored food (grain, flour, cheese, dried fruit, etc.) is well known. Control can only be correctly organized if one can distinguish harmful species from useful predatory mites, and if one knows the biology of each species.

Hughes' book, "The Mites of Stored Food" is the only extensive summary to deal with harmful and useful mites of different taxonomic groups associated with the storage of food products. The first edition (The Mites Associated with Stored Food Products) was published in 1948. The book here reviewed has only just been published.

Although the general outline of the book has been maintained the content is greatly altered. The introductory sections have been greatly enlarged. These sections deal with the order and suborders of mites (especially the suborder Sarcoptiformes, which are of great economic significance as store pests). Details of the structure of some species are given with greater care and in greater detail. Information absent from the first edition includes synonyms, some information on biology, and indication of geographic distribution.

The size has been increased from 168 to 257 pages. The book is profusely illustrated with well executed drawings (the first edition contained 250 drawings and the present edition contains 385). The bibliography is more complete (124 references as against 19 in the first edition). The supplement contains brief notes on the study of mites, the preparation of mounts, and the composition of the media for the mounts.

The book is well produced. It will certainly be of use both to practical workers and to acarologists.

Without making a detailed examination of Hughes' taxonomy, I should like to note the following points. When describing the order Acarina he does not stress the extremely important organizational feature found in all Acarina — generalization of the gnathosoma. The tyroglyphoid mites, which are a major group of storage pests, are described from the work of E. and F. Türk (1959), some points in which are disputable. There is no system to the information on geographic distribution for some species (p. 45 — "United Kingdom, USA, Belgium, Germany, Iceland"; p. 50 — "United Kingdom, New Zealand, Turkey"; p. 81 — "France, Italy, United Kingdom, USSR, Germany, USA"; etc.).

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RUSSIAN JOURNALS FREQUENTLY CITED

[Biological Sciences]

Abbreviation[1]	Journal[1]	Translation
Agrobiol.	Agrobiologiya	Agrobiology
Akusherstvo i Ginekol.	Akusherstvo i Ginekologiya	Obstetrics and Gynecology
Antibiotiki	Antibiotiki	Antibiotics
Aptechnoye Delo	Aptechnoye Delo	Pharmaceutical Transactions
Arkh. Anat. Gistol. i. Embriol.	Arkhiv Anatomii Gistologii i Embriologii	Archives of Anatomy, Histology, and Embryology
Arkh. Biol. Nauk SSSR	Arkhiv Biologicheskikh Nauk SSSR	Archives of Biological Science USSR
Arkh. Patol.	Arkhiv Patologii	Archives of Pathology
Biofizika	Biofizika	Biophysics
Biokhimiya	Biokhimiya	Biochemistry
Biokhim. Plovod i Ovoshchey	Biokhimiya Plovod i Ovoshchey	Biochemistry of Fruits and Vegetables
Bot. Zhur.	Botanicheskiy Zhurnal	Journal of Botany
Byull. Eksptl. Biol. i Med.	Byulleten' Eksperimentalnoy Biologii i Meditsiny	Bulletin of Experimental Biology and Medicine
Byull. Moskov. Obshchestva Ispytateley Prirody, Otdel Biol.	Byulleten' Moskovskogo Obshchestva Ispytateley Prirody, Otdel Biologicheskiy	Bulletin of the Moscow Naturalists Society, Division of Biology
Doklady Akad. Nauk SSSR	Doklady Akademii Nauk SSSR	Proceedings of the Academy of Sciences USSR
Eksptl. Khirurg.	Eksperimentalnaya Khirurgiya	Experimental Surgery
Farmakol. i Toksikol.	Farmakologiya i Toksikologiya	Pharmacology and Toxicology
Farmatsiya	Farmatsiya	Pharmacy
Fiziol. Rasteniy	Fiziologiya Rasteniy	Plant Physiology
Fiziol. Zhur. SSSR	Fiziologicheskiy Zhurnal SSSR im. I. M. Sechenova	I. M. Sechenov Physiology Journal USSR
Gigiyena i Sanit.	Gigiyena i Sanitariya	Hygience and Sanitation
Izvest. Akad. Nauk SSSR, Ser. Biol.	Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya	Bulletin of the Academy of Sciences USSR, Biology Series
Izvest. Tikhookeanskogo N. I. Inst. Rybnogo Khoz. i Okeanog.	Izvestiya Tikhookeanskogo N. I. Instituta Rybnogo Khozyaystva i Okeanografii	Bulletin of the Pacific Ocean Scientific Institute of Fisheries and Oceanography
Khirurgiya	Khirurgiya	Surgery
Klin. Med.	Klinicheskaya Meditsina	Clinical Medicine
Lab. Delo	Laboratornoye Delo (po Voprosam Meditsiny)	Laboratory Work (on Medical Problems)
Med. Parazitol.	Meditsinskaya Parazitologiya i Parazitarnye Bolezni	Medical Parasitology and Parasitic Diseases
Med. Radiol.	Meditsinskaya Radiologiya	Medical Radiology
Med. Zhur. Ukrain.	Medichniy Zhurnal Ukrainskiy	Ukrainian Medical Journal
Mikrobiologiya	Mikrobiologiya	Microbiology
Mikrobiol. Zhur.	Mikrobiologichniy Zhurnal	Microbiology Journal
Nevropatol. Psikhiat. i Psikhogig.	Nevropatologiya, Psikhiatriya i Psikhogigiyena	Neuropathology, Psychiatry and Psychohygiene
Ortoped., Travmatol. i Protez.	Ortopediya, Travmatologiya i Protezirovaniye	Orthopedics, Traumatology and Prosthetics
Parazitol. Sbornik	Parazitologicheskiy Sbornik	Parasitology Collection
Pediatriya	Pediatriya	Pediatrics
Pochvovedeniye	Pochvovedeniye	Soil Science
Priroda	Priroda	Nature
Problemy Endokrinol. i Gormonoterap.	Problemy Endokrinologii I Gormonoterapii	Problems of Endocrinology and Hormone Therapy
Problemy Gematol.	Problemy Gematologii i Perelivaniya Krovi	Problems of Hematology and Blood Transfusion
Problemy Tuberk.	Prolemy Tuberkuleza	Problems of Tuberculosis

[1] Board of Geographic Names Transliteration System.

Sovet. Med.	Sovetskaya Meditsina	Soviet Medicine
Sovet. Vrachebnyy Zhur.	Sovetskiy Vrachebnyy Zhurnal	Soviet Physicians Journals
Stomatologiya	Stomatologiya	Stomatology
Terap. Arkh.	Terapevticheskiy Arkhiv	Therapeutic Archives
Trudy Gelmint. Lab.	Trudy Gelmintologicheskoy Laboratoriya	Transactions of the Helminthology Laboratory
Trudy Inst. Genet.	Trudy Instituta Genetiki	Transactions of the Institute of Genetics
Trudy Inst. Gidrobiol.	Trudy Instituta Gidrobiologiya	Transactions of the Institute of Hydrobiology
Trudy Inst. Mikrobiol.	Trudy Instituta Mikrobiologiya	Transactions of the Institute of Microbiology
Trudy Inst. Okean.	Trudy Instituta Okeanologii. Akademii Nauk SSSR	Transactions of the Institute of Oceanology, Academy of Sciences, USSR
Trudy Leningrad. Obshchestva Yestestvoisp.	Trudy Leningradskogo Obshchestva Yestestvoispytateley	Transactions of the Leningrad Society of Naturalists
Trudy Vsesoyuz. Gidrobiol. Obshchestva	Trudy Vsesoyuznogo Gidrobiologicheskogo Obshchestva	Transactions of the All-Union Hydrobiological Society
Trudy Vsesoyuz. Inst. Eksptl. Med.	Trudy Vsesoyuznogo Instituta Eksperimental'noy Meditsiny	Transactions of the All-Union Institute of Experimental Medicine
Ukrain. Biokhim. Zhur.	Ukrainskiy Biokhimichniy Zhurnal	Ukrainian Biochemical Journal
Urologiya	Urologiya	Urology
Uspekhi Biokhimii	Uspekhi Biokhimii	Progress in Biochemistry
Uspekhi Sovremennoy Biol.	Uspekhi Sovremennoy Biologii	Progress in Contemporary Biology
Vestnik Akad. Med. Nauk SSSR	Vestnik Akademii Meditsinskikh Nauk SSSR	Bulletin of the Academy of Medical Science, USSR
Vestnik Khirurg. im. Grekova	Vestnik Khirurgii imeni Grekova	Grekov Bulletin of Surgery
Vestnik Leningrad. Univ. Ser. Biol.	Vestnik Leningradskogo Universiteta, Seriya Biologii.	Journal of the Leningrad University, Biology Series
Vestnik Moskov. Univ., Ser. Biol. i Pochvov.	Vestnik Moskovskogo Universiteta, Seriya Biologii i Pochvovedeniya	Bulletin of the Moscow University, Biology and Soil Science Series
Vestnik Oftalmol.	Vestnik Oftalmologii	Bulletin of Ophthalmology
Vestnik Oto-rino-laringol.	Vestnik Oto-rino-laringologii	Bulletin of Otorhinolaryngology
Vestnik Rentgenol. i Radiol.	Vestnik Rentgenologii i Radiologii	Bulletin of Roentgenology and Radiology
Vestnik Venerol. i Dermatol.	Vestnik Venerologii i Dermatologii	Bulletin of Venereology and Dermatology
Veterinariya	Veterinariya	Veterinary Science
Vinodeliye i Vinogradarstvo	Vinodeliye i Vinogradarstvo SSSR	Wine-Making and Viticulture
Voprosy Klin.	Voprosy Klinicheskiye	Clinical Problems
Voprosy Med. Khim.	Voprosy Meditsinskoy Khimii	Problems of Medical Chemistry
Voprosy Med. Virusol.	Voprosy Meditsinskoy Virusologii	Problems of Medical Virology
Voprosy Nevrokhirurg.	Voprosy Nevrokhirugii	Problems of Neurosurgery
Voprosy Onkol.	Voprosy Onkologii	Problems of Oncology
Voprosy Pitaniya	Voprosy Pitaniya	Problems of Nutrition
Voprosy Psikhologii	Voprosy Psikhologii	Problems of Psychology
Voprosy Virusologii	Voprosy Virusologii	Problems of Virology
Vrachebnoye Delo	Vrachebnoye Delo	Medical Profession
Zav. Lab.	Zavodskaya Laboratoriya	Factory Laboratory
Zhur. Mikrobiol., Epidemiol. i Immunobiol.	Zhurnal Mikrobiologii, Epidemiologii i Immunobiologii	Journal of Microbiology, Epidemiology, and Immunobiology
Zhur. Nevropatol. i Psikhiat.	Zhurnal Nevropatologii i Psikhiatrii imeni S. S. Korsakova	S. S. Korsakov Journal of Neuropathology and Psychiatry
Zhur. Obshchey Biol.	Zhurnal Obshchey Biologii	Journal of General Biology
Zhur. Vysshey Nerv. Deyatel.	Zhurnal Vysshey Nervnoy Deyatel'nosti imeni I. P. Pavlova	I. P. Pavlov Journal of Higher Nervous Activity
Zool. Zhur.	Zoologicheskiy Zhurnal	Journal of Zoology

ERRATA

In the article by K. A. Breyev, entitled "Biological Principles of the Control of Warble-Flies, on page 36, Volume 40, Issue Number 1 of ENTOMOLOGICHESKOYE OBOZRENIYE, the following correction should be made.

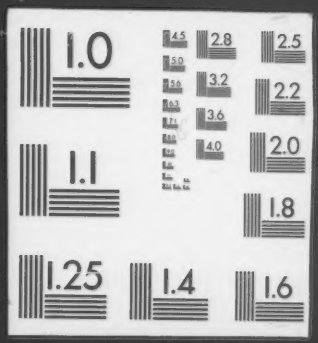
Reads: "order of 450, 000 rubles annually"

Should read: "order of 450, 000, 000 new rubles annually"

ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN RUSSIAN BIO-SCIENCES LITERATURE

Abbreviation (Transliterated)	Significance
AMN SSSR	Academy of Medical Sciences, USSR
AN SSSR	Academy of Sciences, USSR
BIN	Botanical Institute
FTI	Institute of Physiotherapy
GONTI	State Scientific Technical Institute
GOST	All-Union State Standards
GRRRI	State Roentgenology, Radiology, and Cancer Institute
GTTI	State Technical and Theoretical Literature Press
GU	State University
I Kh N	Scientific Research Institute of Surgical Neuropathology
IL (IIL)	Foreign Literature Press
IONKh	Inst. Gen. and Inorganic Chemistry (N. S. Kurnakov)
IP	Soil Science Institute (Academy of Sciences, USSR)
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd.	Press
LEM	Laboratory for experimental morphogenesis
LENDVI	Leningrad Institute of Dermatology and Venereology
LEO	Laboratory of Experimental Zoology
LIKhT	Leningrad Surgical Institute for Tuberculosis and Bone and Joint Diseases
LIPZ	Leningrad Institute for Study of Occupational Diseases
LIPK	Leningrad Blood Transfusion Institute
Medgiz	State Medical Literature Press
MOPISh	Moscow Society of Apiculture and Sericulture
MVI	Moscow Veterinary Institute
MZdrav	Ministry of Health
MZI	Moscow Zootechnical Institute
LOKhO	Leningrad Society of Orthopedic Surgeons
NIIZ	Scientific Research Institute of Zoology
NINKhI	Scientific Research Institute of Neurosurgery
NIU	Scientific Institute for Fertilizers
NIUIF	Scientific Research Institute of Fertilizers and Insecticides
NIVI	Veterinary Scientific Research Institute
ONTI	Division of the Scientific Technical Press
OTI	Division of Technical Information
RBO	Russian Botanical Society
ROP	Russian Society of Pathologists
SANIIRI	Central Asia Scientific Research Institute of Irrigation
SANIISh	Central Asia Scientific Research Institute of Sericulture
TsNII	All-Union Central Scientific Research Institute
TsNTL	Central Scientific and Technical Laboratory
VASKhNIL	All-Russian Lenin Academy of Agricultural Sciences
VIG	All-Union Institute of Helminthology
VIEM	All-Union Institute of Experimental Medicine
VIR	All-Union Institute of Plant Cultivation
VIUAA	All-Union Institute of Fertilizers, Soil Science, and Agricultural Engineering
VIZR	All Union Plant-Protection Institute
VNIRO	All-Union Scientific Institute of Fishing and Oceanography
ZIN	Zoological Institute (Academy of Sciences, USSR)

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us. — Editor.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